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JOURNAL OF PALEONTOLOGY

JOSEPH A. CUSHMAN, Editor

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JOURNAL OF PALEONTOLOGY

JUNE 1929

A BRYOZOAN FAUNULE FROM THE UPPER GRAHAM FORMATION, PENNSYLVANIAN, OF NORTH CENTRAL TEXAS

RAYMOND C. MOORE
University of Kansas, Lawrence, Kansas

PART II

POLYPORA SIGILLARIA Moore, n. sp.
Plate 15, figs. 12, 14

In our collection are a number of fragments of a *Polypora* of distinctive appearance that are readily separated from all of the other species at hand. The branches are .57 to 1.1 mm. wide and .5 to .6 mm. in thickness, the obverse face nearly flat and the reverse gently rounded or sloping to an ill-defined median angle, which in some cases bears a row of nodes. Fenestrules elongate-ovate, the borders indented by the marginal row of zooecia, 2.5 mm. long, three and one half occurring in 10 mm., according to measurement of the fragments. The dissepiments are moderately narrow, .5 to .6 mm. wide.

The zooecia are arranged in well defined longitudinal alternating rows which form also a distinct diagonal pattern. Twelve to thirteen occur in 5 mm. longitudinally, three and a half in 1 mm. diagonally. The surface of the branch is furrowed or marked by ridges of fine granules, the ridges and furrows bending around the somewhat elevated peristomes of the zooecia in a manner which simulates the

pattern of certain sigillaroid trees. The lower or proximal portion of the peristomes is incomplete and in some cases there is a small opening into the posterior portion of the zooecial tubes just inside the hemisepta. Rather slender, sharp spines not greatly elevated are about as numerous as the zooecial apertures, the spine commonly being located just anterior to the apertures. The reverse side of the branches is strongly striated as are the obverse and reverse sides of the dissepiments.

The appearance of some of the specimens suggests that the peculiar surface markings are due to partial solution of the zoarial face, and that the ridges and furrows are the result of this. However, some of the specimens show finely preserved minute granules and other features which oppose this conclusion. Differences in the form of the branches differentiate them from other specimens in our collections.

POLYPORA HEXAGONA Moore, n. sp.
Plate 15, figs. 13, 17

Two fragments about 10 mm. long by half as wide are readily separated from others in our collection and appear sufficiently distinct to merit description as new species. The branches as seen on the obverse face are straight, .45 to .51 mm. wide and somewhat greater in thickness, measuring about .6 mm. On the reverse face the branches are steep-sided and somewhat narrowly rounded, the crest angularly flexuous bending outward toward the ends of the dissepiments so as to give the fenestrules on this side a distinctly hexagonal appearance. The branches in our specimens are uniformly spaced, indicating that in 10 mm. there would be 10½ branches. From the obverse side the fenestrules are elongate-elliptical, about .9 mm. long by .43 mm. wide, the spacing of the fenestrules indicating 7.3 to 7.6 in 10 mm. Zooecial apertures circular, .08 mm. in diameter, surrounded by a thin peristome; they are arranged in alternating longitudinal series, four rows on each branch, 15 to 17 occurring in 5 mm. At irregular intervals between the zooecia are small nodes or spines, but these do not make regular longitudinal series. The reverse side is smooth or very faintly granulose.

This species is perhaps nearest to *P. nodocarinata* Ulrich which has 8½ to 9 fenestrules in 10 mm. and 19 zooecia in 5 mm; it is characterized by regular rows of distinct spines and it lacks the more or less distinctive hexagonal appearance of the fenestrules in *P. hexagona* as seen from the reverse side.

POLYPORA ARATA Moore, n. sp.
Plate 15, figs. 15-16

Zoarium a flabellate expansion, the largest specimen in our collection measuring about 20 mm. in length and width. Branches straight, .6 to 1.1 mm. in width, the average being .8 mm., bifurcations at infrequent intervals. The obverse face is almost flat, the lateral margins sharply carinate and the reverse with flat or slightly concave sides and sharply rounded top; thickness less than the width, averaging .47 mm. Reverse side of branches smooth or finely striated longitudinally. Fenestrules are elongate-ovate, ranging in length from 1.4 to 1.9 mm. and averaging 1.7 mm., and in width from .55 to .9 mm., averaging .8 mm.; the number of fenestrules in 5 mm. is four and one half. The dissepiments, measuring .43 to .8 mm. and averaging .65 mm. in width, are sharply carinate on the margins, slightly expanded distally, depressed on the obverse side but even or arched above the reverse side of the branches. Zooecial apertures sub-circular, .06 to .08 mm. in diameter, surrounded by a thin peristome almost even with the surface of the branch. The apertures are arranged in four to six alternating ranges, 15 to 16½ apertures occurring in 5 mm. In some specimens the area obliquely above the aperture toward the inside of the branch and obliquely below toward the outside is raised or bears a small pustule which makes a double series of oblique trending low ridges and furrows along the branch.

P. arata most closely resembles *P. hirsuta* but is separated from it by the absence of coarse spines, the lesser thickness of the branches and the more gently sloping sides of the branches on the reverse face. From *P. submarginata* Meek, which corresponds approximately in zoarial measurements, *P. arata* is distinguished by the lack of a prominent row of median tubercles but it resembles it in the sharply carinate margins and some of our specimens bear indistinct longitudinal striae.

POLYPORA VALIDA Moore, n. sp.
Plate 15, fig. 11; plate 16, fig. 18

Zoarium a robust frond represented in our collection by numerous specimens 10 to 20 mm. long by as much as 10 mm. in width. Branches .75 to .9 mm. in width, except below bifurcation where they may increase to 1.2 mm. or slightly more; obverse face gently arched to nearly flat, lateral margins and crest of the reverse side sharply rounded and the very steeply sloping sides on the reverse distinctly

flattened. The branch is approximately as thick as wide and has a sub-triangular cross-section. Fenestrules elongate-ovate, .7 to .9 mm. in average width by 1.8 to 2.0 mm. long; there are 3.8 to 4 fenestrules in 10 mm. The dissepiments are broad, .65 to .85 mm. across, and are very slightly depressed on both faces or even with the reverse side of the branches. Apertures sub-circular, .06 mm. in diameter, surrounded by a thin peristome which is generally incomplete on the posterior side. The apertures of the middle ranges are not raised above the zoarial surface but those on the lateral margins are more or less pustulose. The zooecia are arranged in four to six alternating series, the average being five; below bifurcations there may be as many as eight rows. Longitudinally there are 13½ to 14 apertures in 5 mm. Well preserved specimens show the presence of very minute spinules which typically are arranged near the lateral margins of the zooecial apertures.

There are several Pennsylvanian species of *Polypora* which are more or less similar to this form in the size and spacing of the branches, and a smaller number corresponds in the spacing and general character of the fenestrules. *P. submarginata* Meek resembles it most closely in zoarial measurements but is distinguished by the

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EXPLANATION OF PLATE 15

FIGS. 1–3.—*Pinnatopora pustulosa* Moore, n. sp. 1, obverse view of a cotype showing lateral midribs, ×10; 2, obverse view of another cotype, ×10; 3, reverse side of the specimen shown in fig. 1, ×10.

4, 5, 10.—*Pinnatopora oculata* Moore, n. sp. 4, reverse side of one of the cotypes, ×10; 5, obverse view of this specimen, ×10; 10, obverse view of a small specimen, apparently a lateral midrib with secondary pinnae, ×10.

6–9.—*Pinnatopora trilineata* var. *texana* Moore, n. var. 6, reverse side of a specimen showing lateral midrib, ×10; 7, obverse view of a cotype, ×10; 8, reverse side of this specimen, ×10; 9, obverse view of another cotype, ×10.

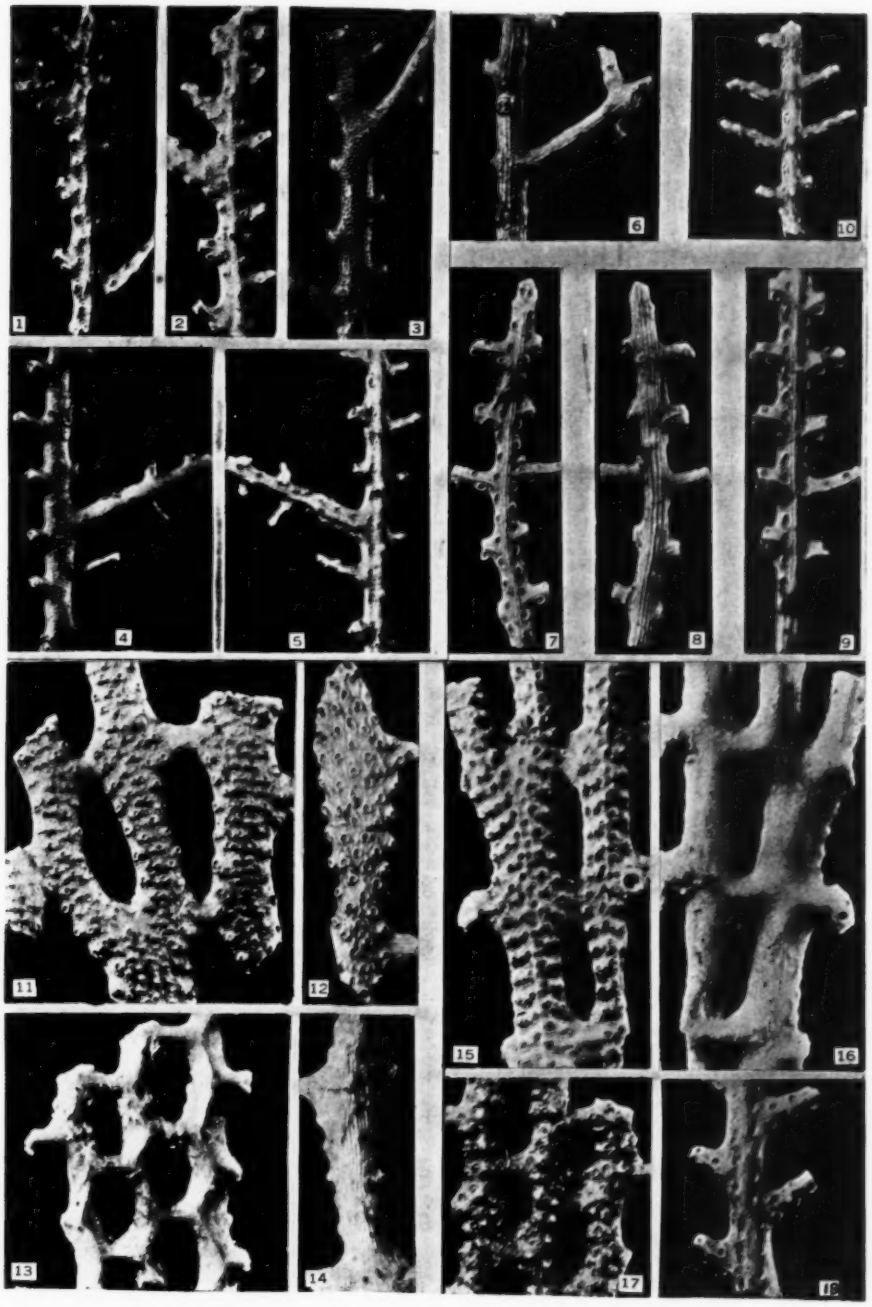
11.—*Polypora valida* Moore, n. sp. Obverse side of a cotype, ×10.

12, 14.—*Polypora sigillaria* Moore, n. sp. 12, obverse view of a cotype, ×10; 14, reverse side of this specimen, ×10.

13, 17.—*Polypora hexagona* Moore, n. sp. 13, reverse view of a cotype, ×10; 17, obverse view of a cotype, ×10.

15–16.—*Polypora arata* Moore, n. sp. 15, obverse view of a cotype, ×10; 16, reverse side of this specimen, ×10.

18.—*Acanthocladia simplex* Moore, n. sp. Obverse view of a cotype, ×10.



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more sharply carinate lateral margins of the branches and by the presence of a row of distinct nodes along the median portion of the branches. *P. remota* Condra has slightly longer fenestrules and is characterized by very small slender dissepiments. *P. triangularis* Rogers has thick subtriangular branches like *P. valida* but somewhat longer fenestrules and is distinguished by a rather prominent row of nodes on the reverse side. *P. distincta* Ulrich, which may be represented by some specimens in our collection, is marked by its much narrower and longer fenestrules.

Family ACANTHOCLADIIDAE Zittel

Genus PINNATOPORA Vine

PINNATOPORA PUSTULOSA Moore, n. sp.
Plate 15, figs. 1-3

Zoarium pinnate, midrib .36 to .57 mm. wide, numerous specimens up to 10 mm. long bearing only pinnae but others carrying strong lateral midribs, .48 to .55 mm. wide. Reverse side evenly rounded and bearing longitudinal rows of tubercles, obverse rounded and rising to a moderately sharp crested, not well defined median keel bearing from 4½ to 9 nodes in 5 mm. The lateral midribs and the pinnae diverge from the main midrib at an angle of about 50 degrees. The pinnae occur nearly opposite or in alternating position, 4.3 to 5 occurring on one side in 5 mm. Zooecial apertures in two alternating ranges small and in most cases not prominent, but generally marked by a slight swelling below the apertures; 13 to 14.7 in 5 mm., so arranged that one occurs opposite the upper half of each pinna and two in the space between the pinnae. Apertures subcircular to pyriform, .11 by .07 mm. in diameter.

This species is distinguished from *P. bellula* Ulrich by its more robust form, the presence of three instead of two apertures on the midrib between the pinnae and in the presence of a keel.

PINNATOPORA OCULATA Moore, n. sp.
Plate 15, figs. 4, 5, 10

Zoarium pinnate, midribs straight, .36 to .42 mm. wide, entire surface covered with granules, the reverse side evenly rounded and the granules more or less distinctly arranged in longitudinal rows. An

occasional specimen shows the presence of a lateral midrib, about .32 to .43 in width. Obverse face bearing a strong rounded mesial carina .09 to .15 mm. in width, carrying moderately strong nodes which in most cases are .9 mm. apart. Pinnae about .21 mm. wide and from 1 to 2 mm. in length, nearly opposite or in alternating position on each side of the midrib, 5.9 to 6.5 pinnae on one side in 5 mm. Zooecial apertures in two alternating ranges, 12 to 13 in 5 mm., elongate and angulated at the anterior and posterior margins somewhat resembling the human eye, .14 mm. long by .085 mm. wide, surrounded by a thin peristome. Apertures slightly more closely crowded on the pinnae, 3½ to 4 in 1 mm.

This species is distinguished by its prominent keel and the distinctive appearance of the apertures. It most closely resembles *P. pyriformipora* Rogers which is distinguished by the much closer spacing of the zooecia and other characters.

PINNATOPORA TRILINEATA var. TEXANA Moore, n. sp.
Plate 15, figs. 6-9

Zoarium pinnate, primary midrib .42 to .55 mm. in width, giving off at long intervals lateral midribs, .35 to .4 mm. in width. There are many specimens up to 8 mm. in length without lateral midribs. Pinnae .27 to .36 mm. wide, nearly opposite or alternating in position on each side of the midrib, 4.9 to 5.2 on each side in 5 mm. Obverse face of midribs and pinnae gently convex and bearing along the median portions a slightly flexuous keel which is bluntly rounded and very little elevated and is bounded on each side by slightly lower and smaller rounded ridges, the combined width of the three ridges measuring .14 to .17 mm. Zooecia in two alternating ranges on midribs and pinnae, 15½ to 16 occurring in 5 mm. on the midrib, and 3 in 1 mm. on the pinnae. Apertures subcircular to elliptical, .085 by .11 mm. in diameter, surrounded by a bluntly topped peristome; normally one aperture occurs opposite the upper half of the base of each pinna and two in the space between. The reverse face is convexly rounded and bears strong longitudinal striae. The entire surface, obverse and reverse, is minutely granulose.

According to Meeks description and figures the type of this species which comes from the upper Pennsylvanian at Nebraska City, Neb., bears 4.4 pinnae on each side in 5 mm. The pinnae are apparently longer, narrower, and carry much more closely crowded apertures than is the case in our specimens. (Meek, U. S. Geol. Surv. of Neb.,

1872, p. 157, pl. 7, figs. 4a, b). Ulrich (Geol. Surv. of Ill., vol. 8, p. 620, pl. 66, fig. 6) has described specimens from the Upper Coal Measures of Illinois which he assigns to Meek's species. He states that of about 100 specimens examined all show six pinnae in 5 mm. and there are apparently other minor distinctions from Meek's specimens. The form which is here designated as the variety *texana* is exceedingly abundant and shows constant differences in measurements both from those of Meek and of Ulrich. Probably Ulrich's specimens should be designated as a distinct variety.

Genus ACANTHOCLADIA King

ACANTHOCLADIA SIMPLEX Moore, n. sp.

Plate 15, fig. 18; plate 16, fig. 15

Zoarium pinnate, midrib robust, sub-cylindrical, .6 to .85 in width and thickness. Pinnae short tapering, .5 to 1.5 mm. in length, .36 to .42 mm. in width at the base and very narrow at the end, diverging at an angle of about 60 degrees from the midrib. Zooecial apertures circular, .1 mm. in diameter, arranged in two rows on midrib and pinnae, about 18 occurring in 5 mm. Small accessory pores are about as numerous as the zooecia on the obverse face but excepting one or two at the base of the pinnae, do not occur on the reverse side, which is finely striated longitudinally.

This species is distinguished from the associated *A. ciscoensis* by the angle at which the pinnae diverge from the midrib, absence of spines and somewhat smaller, more widely spaced zooecia on the obverse face and the smoothly striated reverse side.

ACANTHOCLADIA CISCOENSIS Moore, n. sp.

Plate 16, figs. 13, 14

Zoarium a robust pinnate stipe, very numerous specimens in our collection averaging from 6 to 8 mm. long and none exceeding 10 mm. Midribs stout, .67 mm. in width and nearly as thick. Rather short pinnae, .6 mm. wide at the base or a little less and tapering slightly to a bluntly rounded end, occur in alternating or opposite positions on each side of the midribs, four to four and one quarter occurring on each side in 5 mm. The pinnae extend approximately at right angles to the main stem and are gently to somewhat strongly reflected from the poriferous face. Zooecial apertures circular, .12

mm. in diameter, surrounded by a thin peristome, arranged in two fairly distinct though slightly irregular alternating rows, or locally in three rows, 20 apertures occurring in each row in 5 mm. There are commonly three rows, sometimes two, on the pinnae. Accessory pores are rather prominent and about as numerous as the zooecia. Minute to moderately large spines are irregularly distributed on the poriferous side. The reverse is marked by fine longitudinal striae and bears scattered accessory pores along the median portion of the branch, about ten to fifteen in 5 mm. Obverse face irregularly granulo-striate.

A. ciscoensis agrees most closely in zoarial measurements with *A. pinnata* Rogers. In the latter species the pinnae are somewhat more closely spaced, five in 5 mm., the zooecia are distinctly elongate rather than circular and are somewhat more widely spaced, 18 in 5 mm., and neither in figures nor in the descriptions is there indication of the rather numerous accessory pores which are prominent on *A. ciscoensis*. *A. fruticosa* Ulrich is a much more robust species distinguished particularly by the rows of accessory pores on the reverse side near the margins.

ACANTHOCLADIA CISCOENSIS var. GRANULOSA Moore, n. var.
Plate 16, figs. 16, 17

This form, possibly representing a distinct species, has about the same sized midrib and pinnae as *A. ciscoensis* but about 3 to 3¼ pinnae occur in 5 mm. and about 16 instead of 20 zooecia occur in the space of 5 mm. The wavy longitudinal striae on the obverse and narrow straight striations on the reverse observed in *A. ciscoensis* are not seen here but instead the surface is finely granulose. Accessory pores are abundant on the reverse side.

ACANTHOCLADIA CISCOENSIS var. IRREGULARIS Moore, n. var.
Plate 16, figs. 20, 21

A variety exhibiting rather constant differences from the typical species is represented in our collection by several specimens. The measurements and general appearance are the same, but the apertures on the celluliferous side are much more irregularly placed, and on the reverse side the accessory pores are much more numerous. About 30 to 35 pores occur in the space of 5 mm. along the midrib and on the pinnae they form a closely crowded narrow row. These characters seem to be constant and readily distinguish them.

Genus SEPTOPORA Prout

SEPTOPORA ALTERNATA Moore, n. sp.

Plate 16, figs. 1, 7, 19

Zoarium pinnate, the midribs .55 to .6 mm. wide, branches .42 to .48 mm. wide, 6½ in 10 mm. on each side of the midrib, diverging at an angle of 50 to 55 degrees; measured at right angles to the branches, 7½ to 8 occur in 10 mm. Dissepiments rather straight, about .3 mm. wide and the spacing indicates about 6½ in 10 mm. Zooecial apertures in two alternating rows on midribs and branches, 15 to 15½ occurring in 5 mm.; four to five apertures on the dissepiments. Diameter of the apertures about .14 mm., interspaces between zooecia .2 mm. A narrow somewhat ill-defined keel on midribs and branches bears small nodes .55 to .9 mm. apart, the average being about .7 mm. Small accessory pores, diameter about .04 mm., occur regularly between the zooecial apertures of each longitudinal series and in addition there are a few along the keel. On the reverse side the pores are extremely sparse and faint, and in part they are absent. The entire surface is covered with distinct longitudinal striations.

In its pinnate form and the somewhat regular alternating accessory pores and zooecial apertures, this species most strongly resembles *S. interporata* Rogers. Our species is distinguished by its slightly coarser branches, their distinctly wider spacing along the midrib, wider spacing of the zooecia and nodes on the keel, and other minor characters. It differs from *S. pinnata* Ulrich in the size and spacing of the branches and in the greater abundance of accessory pores on the obverse face. The forms figured by Condra as *S. pinnata* appear to have much coarser branches and smaller fenestrules than Ulrich's type.

SEPTOPORA ALTERNATA var. SPINULOSA Moore, n. var.

Plate 16, figs. 2, 4, 5

This form, which is possibly a distinct species, has the pinnate zoarium of *S. alternata* and agrees with it in general measurements. It is distinguished by the development along the median portion of midrib, branches, and pinnae of tall somewhat asymmetrical spines, some of which reach a height of .27 mm. Several of the spines bear two accessory pores on opposite sides. The spines are somewhat more closely spaced than the nodes in *S. alternata*, measuring here .25 to .5 mm., the average being about .4 mm. There are 17 to 18

zooecia in 5 mm. with an accessory pore regularly between each aperture. The reverse side is longitudinally striated and bears fairly common accessory pores.

In the spacing of the zooecia and the presence and spacing of nodes along the keel *S. alternata spinulosa* resembles *S. multipora* Rogers. It is distinguished by the greater width of the branches diverging from the midrib, .45 to .55 mm. instead of .3 mm.; their angle of divergence, which is 50 to 55 degrees in our specimens and 70 to 75 degrees in those of Rogers; and the closer spacing of the branches in *S. multipora* than in our form.

SEPTOPORA BLANDA Moore, n. sp.
Plate 16, figs. 6, 12; plate 17, fig. 2

Our collection contains several specimens, the largest about 6 by 5 mm., that exhibit characters readily distinguishing them. The

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EXPLANATION OF PLATE 16

FIGS. 1, 7, 19.—*Septopora alternata* Moore, n. sp. 1, obverse side of a cotype, ×10; 7, same, ×5; 19, reverse side of a cotype, ×10.

2, 4, 5.—*Septopora alternata* var. *spinulosa* Moore, n. var. 2, reverse side of a cotype, ×10; 4, obverse view of another cotype, ×5; 5, portion of this specimen, ×10.

3, 11.—*Septopora robusta* var. *paucipora* Moore, n. var. 3, obverse view of a cotype, ×5; 11, obverse side of a cotype, ×10.

6, 12.—*Septopora blanda* Moore, n. sp. 6, obverse view of a cotype, ×5; 12, obverse side of one of the cotypes, ×10.

8.—*Septopora robusta* var. *decora* Moore, n. var.? Obverse of a specimen not quite typical of the species, ×5.

9, 10.—*Septopora robusta* var. *decora* Moore, n. var. 9, reverse side of one of the cotypes, ×10; 10, reverse of another cotype, ×5.

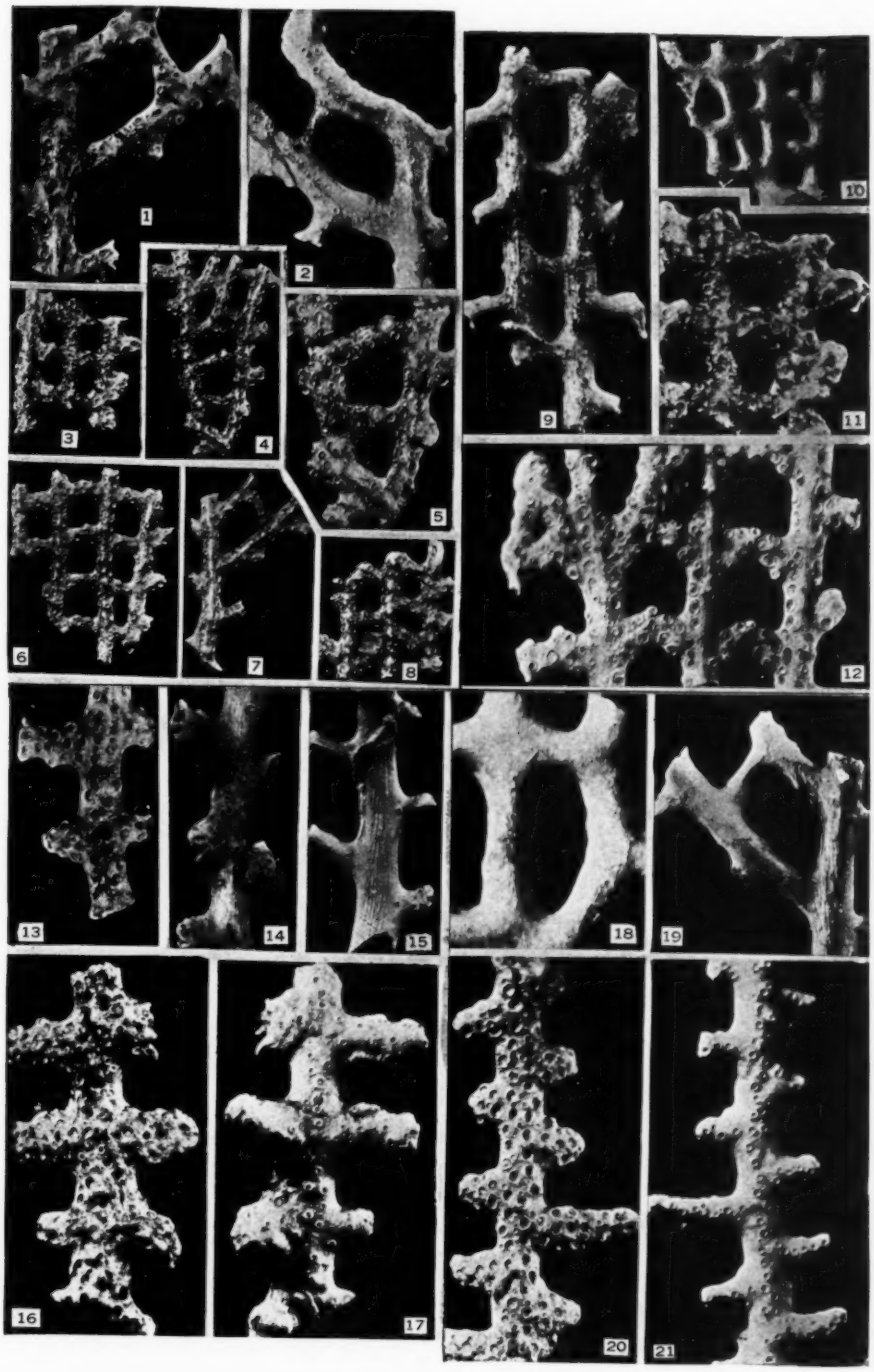
13, 14.—*Acanthocladia ciscoensis* Moore, n. sp. 13, portion of the obverse side of a cotype, ×10; 14, reverse side of a cotype, ×10.

15.—*Acanthocladia simplex* Moore, n. sp. Reverse side of a cotype, ×10.

16, 17.—*Acanthocladia ciscoensis* var. *granulosa* Moore, n. var. 16, obverse view of a cotype, ×10; 17, reverse side of this specimen, ×10.

18.—*Polypora valida* Moore, n. sp. Portion of the reverse side of a cotype, ×10.

20, 21.—*Acanthocladia ciscoensis* var. *irregularis* Moore, n. var. 20, obverse side of a cotype, ×10; 21, reverse side of this specimen, ×10.



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branches are .55 to .6 mm. wide, six and one half to eight occurring in 10 mm. Dissepiments gently curved, .4 to .55 mm. wide. Fenestrules subcrescentic, about seven in 10 mm. The zooecial apertures are large, subcircular, measuring .15 mm. in diameter, surrounded by a distinct peristome; there are 18 to 19 in 5 mm. Accessory pores averaging .1 mm. in diameter are about half as numerous as the zooecia, and in parts of the zoarium occur more or less regularly between the zooecial apertures. The median portion of the branches bear a distinct, low, longitudinally striated keel, .15 mm. wide. Low spines occur along the keel at intervals ranging from .4 to .85 mm., the average being .6 mm. The reverse of the branches and dissepiments is finely striated longitudinally and shows almost no accessory pores. The dissepiments are slightly depressed below the branches.

This species is distinguished from *S. biserialis* Swallow by its closer spacing of branches and dissepiments, slightly larger and more widely spaced zooecia, and other minor characters. From the associated *S. robusta decora* which agrees closely in general measurements and in the spacing of the zooecia *S. blanda* is distinguished by the lesser thickness of its branches and dissepiments and by the very different character of the reverse face.

SEPTOPORA ROBUSTA var. DECORA Moore, n. sp.
Plate 16, figs. 8-10; plate 17, fig. 1

A fairly common form in the Wayland fauna is a *Septopora* that is evidently closely allied to Ulrich's *S. robusta*. The branches are .57 to .7 mm. wide, seven occurring rather regularly in a space of 10 mm. The dissepiments are straight to gently arched, moderately thick, .5 mm. wide, and of approximately the same thickness as the branches. The zooecial apertures are large, measuring about .15 mm. in diameter, surrounded by a distinct peristome, 18½ to 20 occurring in 5 mm., the average being rather uniformly 19½. Accessory pores ranging from .08 to .11 in diameter are rather common but are not as abundant as the zooecial apertures. There is no keel, but along the median portion of the branches are rather prominent nodes or spines, the interval between them ranging from .5 to .9, the average being .75 mm. The surface is marked by wavy granulose striations both on the obverse and reverse sides. The reverse is marked by rather abundant accessory pores.

The form in our collection appears to be distinguished from typical *S. robusta* by the smaller size of the branches and the wider spacing of the zooecia. It is apparent from Ulrich's description and fig-

ures that the obverse side of his specimen was not seen. He makes no mention of the appearance of this side of the zoarium, but it is probable that, like our material, the type of *S. robusta* carries prominently developed spines along the median portion. If this is not the case, the variety in the Graham beds is still more distinct. It is possible that the reverse side of Ulrich's specimen was slightly worn or it may differ from ours, since it is represented as essentially smooth. In typical *S. robusta* the dissepiments are depressed on the reverse side; in the variety in hand these are practically even with the branches. Condra figures a Nebraska specimen that he identifies as *S. robusta* which shows numerous large blunt nodes which are spaced about .46 mm. apart. His specimens show striae on the reverse side but no ornamentation on the obverse.

SEPTOPORA ROBUSTA var. PAUCIPORA Moore, n. var.
Plate 16, figs. 3, 11; plate 17, figs. 6, 7

This variety, represented by several specimens showing common characters, has slightly more slender branches than in typical *S. robusta*. They measure .5 to .57 mm. in width and 8 to 8½ occur in 10 mm. The dissepiments are robust, .5 to .55 mm. in width and 8½ to 9 fenestrules occur in 10 mm. The zooecial apertures are circular, .14 mm. in diameter, and rather closely spaced, 19½ to 21 occurring in 5 mm. Accessory pores, not very numerous, occur where there is space between the zooecia. On the dissepiments are three irregular rows of zooecia. Along the median portion of the branches is a more or less strongly developed spinose keel, the average distance between the spines being .32 mm. The reverse side is longitudinally striated and bears very few accessory pores, these restricted to the median portion of the branches near the end of the dissepiments.

The distinguishing features of this variety are the more or less prominently developed keel and the sparseness of accessory pores on the reverse side. The spacing of branches and dissepiments is somewhat finer than in either *S. robusta* or in *S. robusta decora*.

Family RHABDOMESONTIDAE Vine

The abundance of *Rhabdomeson* and *Rhombopora* in our collections has afforded opportunity for study of a large number of specimens which exhibit noteworthy variation in external and internal charac-

ters. However, recognition of characters that are of value in specific differentiation offers some difficulty, even more than might be the case if only a few of the most distinctly different types were represented in our material.

Both in *Rhombopora* and *Rhabdomeson* the structural organization is simple, consisting essentially of polygonal, narrow-walled tubes in the axial, immature portion of the branch, and subcylindrical thick-walled tubes in the outer mature portion. The immature sections of the tubes are commonly disposed at a lesser angle to the axis of the stem than the radially directed mature parts.

The elements that may show variation are the size, shape, attitude and possibly other characters of the zooecial tubes, the thickness of walls, the presence and nature of accessory structures, the arrangement of zooecia and form of the zoarium. From the standpoint of classification the most significant are presumably the zooecial characters. However, these aid little here for there is small observable distinction between the zooecia of specimens that obviously belong to very different species or, in the case of certain examples, to different genera, families and sub-orders. The size of the zooecial tubes in *Rhabdomeson* is commonly notably less than in *Rhombopora,* but the variation within the genera is not great nor is size necessarily constant in the individual colony. The form of the zooecia exhibits little modification but the degree of radial inflection in different species may vary widely. The arrangement of apertures in the ramose zoarium is largely conditioned by the attitude, that is, the radial divergence of the tubes and the size of the stem. Since the size of the zooecial tubes varies little in different species, it follows that in slender branches the diagonal series of apertures are necessarily more steeply inclined and the angle between intersecting ranges more acute than in larger stems in which geometric conditions impose a lower inclination of the diagonal series and a larger intersecting angle. Arrangement of the apertures is thus in part a function of the size of the stem. The nature of the thickening of the zooecial walls in the cortical zone is much the same in all forms but in some, such as *Rhombopora crassa* Ulrich, it is much more strikingly developed and becomes a character of specific importance. Acanthopores of the two sizes are common in most specimens. The smaller, frequently designated as spiniform tubuli, are termed micracanthopores in this paper, and the larger are conveniently differentiated as megacanthopores. The relative number, arrangement and surface appearance of these may have classificatory value. Diaphragms are

present in some specimens but absent in others; they are never abundant and do not appear to have much significance in systematic studies. Hemisepta are presumably a characteristic or perhaps a diagnostic structural element of the family Rhabdomesontidae, but in many thin sections of *Rhabdomeson* and *Rhombopora* they do not appear clearly, and so far as we can discover, they are entirely absent in the genotype of *Rhombopora, R. lepidodendroides* Meek, in *R. crassa* Ulrich and several other Pennsylvanian species. While many forms possessing hemisepta, chiefly from older strata, are referred to *Rhombopora,*—and these undoubtedly belong with the Rhabdomesontidae, —question may be raised as to the family and subordinal assignment of the genotype and related species that lack hemisepta. The absence of hemisepta and of a well defined vestibular area in the zooecia leaves little if anything to distinguish the latter from the Batostomellidae. Mesopores are not present in *Rhabdomeson* and are presumably absent in *Rhombopora.* The incrusting portion in the region of attachment in the latter genus, and parts of the surface of certain old (?) specimens contain thin-walled, angular depressions between the zooecia, that strongly resemble mesopores. Because of this fact and because of the presence in some forms of irregularities resembling maculae or monticules, Girty has referred specimens from Missouri described by him, to *Batostomella* (*B. greeniana, B. greeniana regularis.*) Many of our more robust rhomboporoid specimens show these "mesopores", but sections fail to indicate that they are true mesopores. This has been discussed in describing the forms designated as *Megacanthopora.*

In the study of fossils, often consisting of fragments of the complete zoarium, variation which may occur in a single colony between the region near the base of attachment, the main stem and the branches indicates need of caution in the attempt to differentiate species. The assumed more or less wide variation due to the age of the colony, and the unknown factor of individual variation due to environment and other possible factors impose doubts as to the classificatory value of certain observed differences. It is probably for this reason that almost all examples of *Rhombopora* occurring in the Pennsylvanian rocks of this country are commonly assigned to *R. lepidodendroides* Meek, which accordingly, is presumed to exhibit the utmost variation in size and appearance, according, possibly, to the portion of the complete zoarium and the growth stage represented by individual specimens.

Considering first the significance of variation in different parts of the zoarium, examination of published figures and descriptions, and of a large number of specimens of these genera supports the conclusion that in all essential characters branches correspond to the stem from which they diverge. The branch may be slightly smaller than the main stem and the number of zooecia transversely around the stem reduced, but the arrangement and general spacing of the apertures, their shape, the nature and development of acanthopores and the internal structure are essentially unaltered. Near the growing end of branch or stem the zoarium comes to a more or less bluntly rounded point over which the thin walls of the immature zooecia may be seen. However, within a few millimeters of the growing end the branch exhibits the surface appearance and diameter of the normal stem. This indicates that mature characters for each species extend throughout practically the entire zoarium and that there is very slight change in the portions of the colony first formed during the growth of the younger parts. In short, we may encounter minor differences in parts of the zoarium, but there seems to be little support for the conclusion that fossil specimens very unlike in appearanc and structure may be associated as representing different parts of a single type of zoarium.

Changes that are presumed to mark the advance from immaturity to old age in a ramose bryozoan colony are: increase in diameter of the stem, thickening of the cortical heavy-walled portion of the zoarium, reduction in size with possible change of shape of the zooecia, accompanying thickening of the surrounding walls, and in senile phases introduction of various irregularities in arrangement of apertures and form of surface. It is certainly true that different specimens exhibit wide variation in the size of the stem, in relative thickness of axial and cortical regions, size and arrangement of apertures, and in other characters. That these represent various stages of a single species or indeed of half a dozen species is open to doubt. Unless there are environmental or other factors making for individual variation in the colonies that are unknown in other bryozoans, one cannot apply the criteria of thickness of zooecial walls or the relative thickness of axial and cortical regions as having solely age significance. There are many small stems of various types with surfaces presumably denoting maturity that have a total diameter less than the immature region of associated larger types. One can hardly suppose that the latter are later growth stages of the former. In the specimens studied by us there is convincing evidence opposing

the possibility of resorption of the inner part of the thick-walled cortical zone.

In a large zoarium the characters of the distal portion might be expected to show much less maturity of development than the portion near the starting of growth. As already noted each individual specimen ordinarily exhibits a remarkable uniformity in structure and appearance throughout the colony. It appears from examination of large and small specimens preserving the distal growing end that the development of full sized surface characters and a diameter equal to that of the mature part of the stem is almost immediately attained. Once the cortical zone is reached and the formation of the thick walled portion begun little further change takes place in the axial region. Addition of calcareous material in the outer area may slightly increase the thickness of the cortex and perhaps restrict the size of the apertures, but if this is of any importance it takes place with great uniformity throughout the zoarium. By reason of the radial divergence of the zooecial tube from the axial region, addition of calcareous deposits may increase the distance transversely between adjacent apertures, but it can not change their longitudinal spacing.

Consideration of the characters discussed leads to the conclusion that a majority of the different forms observed in collections of these fossils represent distinct species rather than fortuitous variations and growth stages of a widely ranging, highly changeable single stock. Indeed the easy recognizable specific differentiation of other bryozoan genera, like *Fenestella*, having structural elements in which the form and micrometric measurements permit definite recognition of specific divisions furnishes *a priori* basis for the expectation that in the ubiquitous *Rhombopora* and probably also in *Rhabdomeson* there should be considerable specific variation. Because attention must be placed on characters which do not admit of very great modification it may not be possible, in some cases, to recognize species which are actually distinct. The characters which appear most useful are the micrometric measurements of the zooecia; the arrangement of zooecia, especially the longitudinal spacing in the zoarium; the general size and mode of growth of the zoarium; and nature and degree of development of acanthopores.

Genus RHOMBOPORA Meek

RHOMBOPORA CORTICATA Moore, n. sp.

Plate 17, figs. 3, 4; text figs. 4 *i*, *j*

Zoarium a fairly robust, straight cylindrical stem, bifurcating at infrequent intervals. Our longest straight specimens measure 20 mm. in length. The diameter appears to range from 1.8 to 2.7 mm. The apertures are elongate-elliptical, rather constant in size, measuring .28 to .29 mm. in length by .16 to .17 mm. in width. The interspaces are moderately thick, rounded on top and carry one or two rows of small bead-like granules representing the micracanthopores. Megacanthopores are present at the ends of the zooecia, but are very little larger than the micracanthopores and do not project strongly. The apertures form very regular diagonal and vertical series, five apertures diagonally occurring in 2.0 mm. and five vertically in 2.8 to 3.0 mm. Transverse sections show a prominent cortical zone which, however, has a thickness less than half the diameter of the axial zone. A specimen measuring 2.5 mm. in diameter has a cortex .57 mm. thick and an axial zone 1.35 mm. in diameter; another with a diameter of 2.3 mm. has a cortex of .53 mm. and an axial zone measuring 1.24 mm. Tangential sections show a moderately thick, dark, dense lining around the zooecial tubes and in the intervening spaces crowded micracanthopores; midway between the zooecia longitudinally or transversely are distinct megacanthopores.

R. corticata appears to be intermediate in several characters between *R. lepidodendroides* Meek and *R. crassa* Ulrich. The apertures are larger and more widely spaced than in the first species, the interspaces more rounded, megacanthopores less prominent and the cortical zone proportionately thicker. In *R. crassa* the apertures are about the same size as in our specimens but are less regular in shape and arrangement, megacanthopores are not observed and the cortical zone is much thicker. *R. subcrassa* Coryell and Morgan is a much more robust species measuring from 3 to 6 mm. in diameter; its apertures are larger and somewhat more closely spaced longitudinally.

RHOMBOPORA PILULA Moore, n. sp.

Plate 17, fig. 14

Zoarium a slender branching stem, about 1.5 to 1.7 mm. in diameter, bifurcating at infrequent intervals, the branches inclined about 45 degrees to the stem. Apertures elliptical, about .43 mm. long by

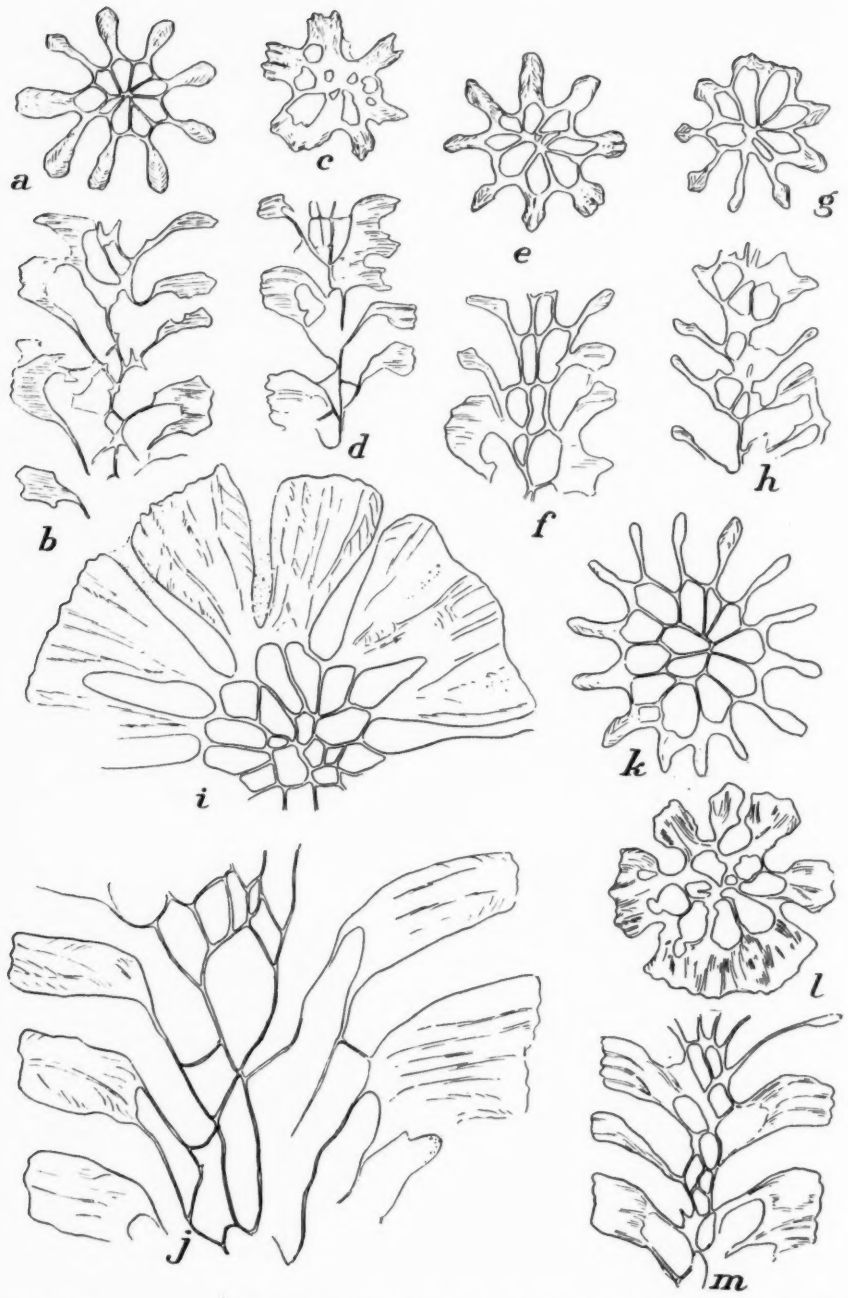


FIG. 4.—Transverse and longitudinal sections of species of *Rhombopora*, ×30. *a, b, R. favata; c, d, R. muralis; e, f, R. constans ampla; g, h, R. constans; i, j, R. corticata; k, R. munda, l, m, R. comunis.*

.26 mm. wide, surrounded by a steeply sloping vestibular area that conforms in shape to the aperture. The arrangement of the apertures in longitudinal series is somewhat more distinct than in diagonal and transverse rows. Including one interspace with each aperture, five apertures occupy a space of 3.0 mm. vertically. There are 15 to 17 alternately disposed vertical ranges around the stem. The angle at the intersection of the diagonal series is about 84 degrees. Internally there is a distinct axial and cortical zone, the former about .65 mm. in diameter. The interspaces carry a row of bead-like prominent subequal acanthopores which form one of the most prominent surficial features. In many places the space longitudinally or transersely between the zooecia is more or less strongly depressed, having somewhat the appearance of a mesopore; however it is merely a surficial depression.

R. pilula is distinguished from *R. lepidodendroides* Meek by noteworthy difference in the appearance of zoarium and a smaller axial zone containing few immature zooecia. *R.* (*Megacanthopora?*) *crassa* Ulrich is a much more robust species with larger axial and cortical areas and without the regular apertures. *R. pilula* seems most closely to resemble some specimens of the associated *R. communis*, which is distinguished chiefly by its average smaller size, smaller apertures in diagonal series that intersect at a smaller angle, and the less prominent bead-like character of the acanthopores.

RHOMBOPORA COMMUNIS Moore, n. sp.
Plate 17, fig. 12; text figs. 4 *l*, *m*

This species, to which a large number of the Rhomboporas of the Wayland shale may be referred, consists of slender cylindrical stems, slightly over 1 mm. in diameter, with bifurcating branches diverging at an angle of about 45 degrees. We have several straight specimens somewhat more than a centimeter in length. The apertures are elongate elliptical, .28 by .14 mm., surrounded by a steeply sloping vestibular area. The interspaces are moderately thick and rounded, carrying crowded bluntly rounded acanthopores which in many places occur in more than a single row. Acanthopores larger than the average size are found at the end of some of the apertures, but in other cases these are not distinctly larger than the rest. The apertures are arranged in somewhat regular longitudinal and diagonal series. Vertically five apertures occur in the space of 3.2 mm. The angle of the

intersecting diagonal series ranges from about 60 to 70 degrees, the average being 65 degrees.

R. communis is distinguished from *R. lepidodendroides* by its relatively wider interspaces with crowded acanthopores and by its smaller immature zone.

RHOMBOPORA CONSTANS Moore, n. sp.
Plate 7, figs. 13; text figs. 4 *g*, *h*

Rather slender stems about 1.0 mm. in diameter with rather elongate narrow elliptical apertures measuring about .29 by .14 mm. Interspaces moderately narrow carrying a single row of very small acanthopores. Diagonal series of apertures intersect at an angle of about 50 degrees. There are typically 17 alternating ranges of zooecia transversely around the stem.

In general appearance *R. constans* most strongly suggests *R. lepidodendroides* Meek, but it appears distinctly smaller and is quite different in internal structure. The narrower interspaces and much more delicate acanthopores distinguish it from *R. communis.*

RHOMBOPORA CONSTANS var. AMPLA Moore, n. var.
Plate 17, fig. 8; text figs. 4 *e*, *f*

A form regarded as a variety of *R. constans* has slightly longer and wider apertures than the typical specimens, measuring .31 by .17 mm. In branches the same size as *R. constans* the diagonal series of apertures rather regularly intersect at an angle of 59 to 61 degrees. The vestibular area is more nearly vertical.

RHOMBOPORA MUNDA Moore, n. sp.
Plate 17, fig. 11; text fig. 4 *k*

Zoarium a cylindrical stem about 1.25 mm. in diameter. The apertures are elongate-elliptical .33 by .18 mm., five occurring vertically in 3.14 mm. The diagonal intersecting series of zooecia are very well defined, the angle between them 40 to 42 degrees. The interspaces between the zooecia are narrow and carry a single row of small acanthopores with slightly larger ones at the end of the aperture. Transersely there are about 26 alternating ranges of zooecia around the stem.

R. munda is distinguished from associated species by the narrow angle between the intersecting diagonal series of the zooecia and by the much larger number of ranges around the stem.

RHOMBOPORA FAVATA Moore, n. sp.
Plate 17, fig. 10; text figs. 4 *a*, *b*

The apertures in this species are distinctly rounded or subhexagonal and the interspaces unusually thin, the vestibular area being deep and practically vertical walled. The apertures typically measure .37 mm. in length by .29 mm. in width. The regular diagonal series of apertures intersect at an angle of about 62 degrees. The diameter of the stem is about 1.0 to 1.15 mm.

RHOMBOPORA MURALIS Moore, n. sp.
Plate 17, fig. 9; text figs. 4 *c*, *d*

Zoarium a slender branch, diameter about 1.0 mm. or less. The apertures moderately large, broadly elliptical to subcircular, .28 to .34 mm. in length by .20 to .25 mm. in width, vestibular area practically vertically walled. Each aperture is surrounded by a close set row of acanthopores that form a narrow ridge or wall, that of each aperture being in general distinct from its neighbor even in the diagonal series. In the space longitudinally or transversely between the apertures there is frequently a walled-in angular depression which in some cases contains one or more scattered acanthopores. These depressions, somewhat resembling mesopores, are merely surficial.

The minute size of this species and the distinctive appearance of the walls of acanthopores around the apertures and the large rounded shape of the deep set apertures are distinctive features.

Genus RHABDOMESON Young and Young

This interesting genus, distinguished from the more common *Rhombopora* by the presence of an axial canal and by the diminutive size of the branches and the zooecia, is abundantly represented in the fauna of the Wayland shale. So far only one species *R. americana*, described by Rogers in 1900, has been reported from America. It was described from the lower Oread limestone at Lawrence, Kansas, and Rogers found specimens which he assigned to his species from the Iola limestone at Kansas City and the Cottonwood limestone at Cottonwood Falls, Kansas. A very interesting new species from the Drum limestone at Kansas City is being described by A. N. Sayre and it is now known that the genus is not uncommon in the Mid-Continent Pennsylvanian strata.

EXPLANATION OF PLATE 17

FIGS. 1.—*Septopora robusta* var. *decora* Moore, n. var. Obverse side of a cotype, ×10.

2.—*Septopora blanda* Moore, n. sp. Reverse side of a cotype, ×10.

3, 4.—*Rhombopora corticata* Moore, n. sp. 3, a cotype, ×2.5; 4, a portion of this specimen, ×10.

5.—*Rhapdomeson filum* Moore, n. sp. A cotype, ×10.

6, 7.—*Septopora robusta* var. *paucipora* Moore, n. var. 6, reverse side of a cotype, ×10; 7, obverse side of another cotype, ×10.

8.—*Rhombopora constans* var. *ampla* Moore, n. var. Surface view of the type, ×10.

9.—*Rhombopora muralis* Moore, n. sp. Surface view of a cotype, ×10.

10.—*Rhombopora favata* Moore, n. sp. Surface view of the type, ×10.

11.—*Rhombopora munda* Moore, n. sp. Surface view of the type, ×10.

12.—*Rhombopora communis* Moore, n. sp. Surface view of a cotype, showing slightly more prominent acanthopores than common, ×10.

13.—*Rhombopora constans* Moore, n. sp. Surface view of a cotype, ×10.

14.—*Rhombopora pilula* Moore, n. sp. Surface view of a cotype, ×10.

15, 16.—*Rhabdomeson tenerum* Moore, n. sp. 15, surface view of the type, ×10; 16, surface view of another specimen, ×10.

17.—*Rhabdomeson bellum* Moore, n. sp. Surface view of the type, ×10.

18, 19.—*Rhabdomeson bellum* var. *minus* Moore, n. var. 18, surface view of the type, ×10; 19, surface view of a specimen showing unusually extended acanthopores, ×10.

20.—*Rhabdomeson decorum* Moore, n. sp. Surface view of the type, ×10.

21.—*Rhabdomeson simulatum* Moore, n. sp. Surface view of a cotype, ×10.

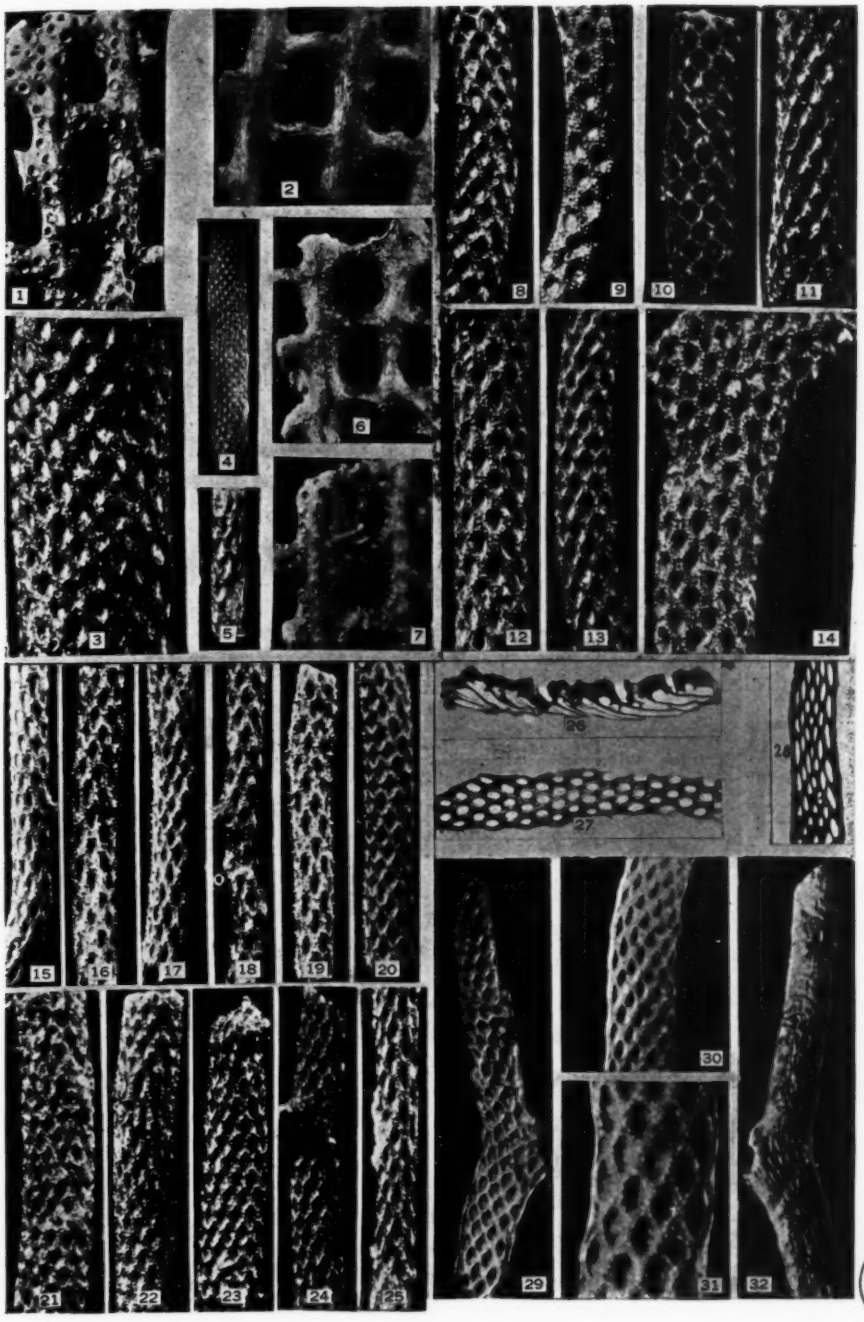
22.—*Rhabdomeson simulatum* var. *spissum* Moore, n. var. Surface view of the type, ×10.

23.—*Rhabdomeson simulatum* var. *debile* Moore, n. var. Surface view of a cotype, ×10.

24.—*Rhabdomeson simulatum* var. *gracile* Moore, n. var. Surface view of the type, ×10.

25.—*Rhabdomeson procerum* Moore, n. sp. Surface view of the type, ×10.

26–32.—*Rhombocladia delicata* Rogers. 26, longitudinal section showing recumbent immature tubes, thickened walls in mature region, diaphragms and hemisepta, ×10; 27, tangential section, not far below obverse face, ×10; 28, tangential section in immature region, ×10; 29, obverse view of a typical specimen, the branch at right broken off, ×10; 30, portion of the obverse of a robust specimen, ×10; 31, a part of the specimen shown in 30, ×25; 32, reverse side of the specimen figured in 29, showing curved growth lines of the basal theca and openings into immature tubes due to weathering, ×10.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RHABDOMESON SIMULATUM Moore, n. sp.
Plate 17, fig. 21; text figs. 5 *2*, *2 a*

Zoarium a slender cylindrical stem, diameter 1.0 to 1.15 mm., branching not observed. Zooecial apertures elongate elliptical .26 mm. by .155 mm. at the bottom of an evenly sloping subrhomboid to hexagonal vestibular area. Interspaces narrow with rather numerous projecting spines, micracanthopores and megacanthopores, the latter chiefly at the angles of the cells. The apertures are rather regularly arranged in intersecting, longitudinal, transverse and diagonal series. Longitudinally five apertures occur in 2.5 mm., and horizontally five in 1.3 mm. In these and like succeeding measurements one interspace is included with each aperture so that the distance is slightly greater than if the outer boundaries of the first and fifth apertures only were included. There are 25 to 26 alternating ranges of apertures transversely around the stem. The axial tube appears to be elliptical in some undistorted specimens, about .23 by .39 mm.; in others it is subcircular, about .30 mm. It contains a few diaphragms and seems also to be divided by thin-walled vesicles which, as seen in transverse sections, may so resemble the polygonal walls of immature zooecia that the presence of an axial tube may be overlooked. The zooecia diverge from the axial tube at an angle of 20 to 23 degrees.

This species is distinguished from *R. americana* Rogers by its more robust stem, larger apertures and axial tube, and by the spacing of the apertures. In *R. americana* five zooecia in longitudinal series occupy the space of 2.24 mm. and five horizontally .68 mm. The angle of divergence of the zooecia from the axial tube is slightly greater, (25 to 29 degrees) in Rogers' species, the tube measures .15 mm. in diameter and there are very few widely separated diaphragms.

RHABDOMESON SIMULATUM var. SPISSUM Moore, n. var.
Plate 17, fig. 22; text figs. 5 *3*, *3 a*

Zoarium a slender cylindrical branch; none of our specimens, the longest 8 mm., show subdivisions of the branch; diameter 1.0 mm. Zooecia arranged in regular longitudinal, transverse and oblique rows, elliptical in outline, .14 by .085 mm. Longitudinally five apertures occur in 2.56 mm., transversely five in 1.21 mm., and diagonally five in 1.42 mm. Transversely there are 22 alternating rows around the stem. Interspaces broad, rounded, covered with numerous small slightly projecting micracanthopores and bluntly rounded megacan-

thopores. Axial tube large, .26 mm. in diameter, containing scattered diaphragms. Zooecial tubes diverge from the axis at an angle of 20 degrees. Thickened cortical region about .15 mm. in diameter.

This form is distinguished by its small apertures, thick granulose interspaces, and by the unusually large size of the axial tube.

RHABDOMESON SIMULATUM var. GRACILE Moore, n. var.
Plate 17, fig. 24; text figs. 5 *4*, *4 a*

This form differs from *R. simulatum* in its slightly smaller diameter, .75 mm., and in the very narrow ridge-like interspaces marked by a single row of crowded acanthopores. Apertures measure .23 by .115 mm., five occurring longitudinally in 2.5 mm., horizontally five in 1.1 mm., and diagonally five in 1.4 mm. Twenty alternating ranges transversely surround the stem. The diameter of the axial tube measures .21 to .22 mm., and the zooecial tubes diverge at an angle of 20 degrees. Vesicles seem to be present in the tube as seen in longitudinal and transverse sections, but diaphragms are not regularly developed.

RHABDOMESON SIMULATUM var. DEBILE Moore, n. var.
Plate 17, fig. 23

This is a beautifully regular stem with thin ridges between the apertures. Most of the specimens are mashed flat so that internal characters are not readily observed. The diameter is about .85 mm., apertures .25 by .10 mm., five apertures occurring longitudinally in 2.70 mm., horizontally in 1.13 mm., and diagonally in 1.35 mm. Twenty-two alternating ranges occur transversely around the stem. Rather prominent blunt acanthopores occur at the cell angles.

RHABDOMESON BELLUM Moore, n. sp.
Plate 17, fig. 17; text figs. 5 *5*, *5 a*

Zoarium a slender cylindrical stem about .68 to .7 mm. in diameter. Apertures moderately elongate and narrow, measuring .26 by .085 mm. Longitudinally five apertures occur in 2.9 mm., horizontally five in 1.0 to 1.3 mm. and diagonally five in 1.4 mm. Nineteen alternating ranges of apertures generally occur around the stem. The interspaces are moderately narrow bearing a row of micracanthopores, which are not very prominent, and large bluntly rounded megacanthopores. The axial tube measures .115 mm. in diameter and the zooecia diverge at an angle of 11 degrees.

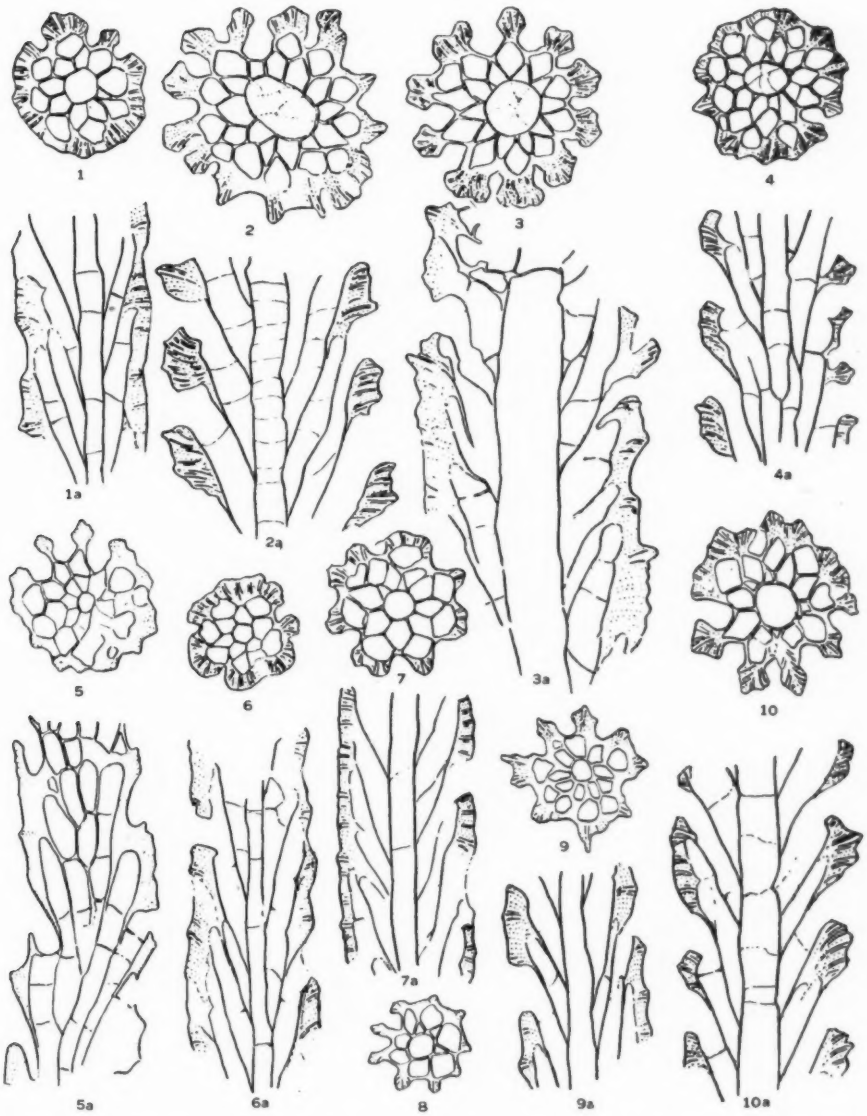

FIG. 5.—Transverse and longitudinal sections of species of *Rhabdomeson*, ×30. *1, 1 a, R. tenerum, 2, 2 a, R. simulatum; 3, 3 a, R. simulatum spissum; 4, 4 a, R. simulatum gracile; 5, 5 a, R. bellum; 6, 6 a, R. bellum minus; 7, 7 a, R. procerum; 8, R. filum; 9, 9 a, R. bellum minus* var.; *10, 10 a, R. decorum.*

This species is distinguished by its very small axial tube and the small angle of divergence of the zooecia. Externally the species somewhat resembles *R. tenerum* but is distinguished by the closer spacing of the apertures longitudinally and wider spacing transversely.

RHABDOMESON BELLUM var. MINUS Moore, n. var.
Plate 17, figs. 18, 19; text figs. 5 *6*, *6 a*, *9*, *9 a*

This form is more slender than *R. bellum*, measuring about .55 to .6 mm. in diameter, but the measurement of zooecia and spacing of apertures is nearly the same. Longitudinally five apertures occur in 2.75 mm., horizontally five in 1.3 mm., and diagonally five in 1.8 mm. Twelve to sixteen alternating rows of apertures surround the stem horizontally. The axial tube measures .115 and zooecia diverge at an angle of 12 to 15 degrees.

RHABDOMESON BELLUM var. SOCIALE Moore, n. var.
Plate 18, fig. 5

A number of specimens of a delicate *Rhabdomeson* mostly matted together and somewhat mashed appear referable to *R. bellum*. They are, however, readily distinguished by the very delicate row of somewhat elongated micracanthopores surrounding the apertures, the thin interzooecial ridges, and the small axial tube measuring 0.10 mm. in diameter. Longitudinally five apertures occur in 2.40 mm. Sixteen to seventeen alternating ranges occur transversely around the stem.

RHABDOMESON PROCERUM Moore, n. sp.
Plate 17, fig. 25; text figs. 5 *7*, *7 a*

Zoarium a slender cylindrical stem about .65 mm. in diameter. The zooecia are unusually elongate, .32 mm. in length by .06 mm. in width; sloping area around the aperture very narrow and steep. Interspaces rather narrow and very closely crowded with acanthopores of large and small size. Longitudinally five apertures occur in 2.5 mm., and diagonally five in 1.55 mm. Fifteen alternating ranges of apertures surround the stem. The axial tube has a diameter of .13 mm., and the zooecia diverge at an angle of 21 degrees.

This species perhaps most closely resembles *R. tenerum* from which it is distinguished by the relatively longer apertures and the much greater angle of divergence of the zooecia from the axial tube.

RHABDOMESON DECORUM Moore, n. sp.
Plate 17, fig. 20; text figs. 5 *10, 10 a*

Zoarium slender, cylindrical, diameter about .75 mm. Apertures elliptical, .2 by .115 mm. Longitudinally there are five apertures in 2.18 mm., horizontally five in 1.2 mm., and diagonally five in 1.25 to 1.35 mm. Eighteen alternating ranges of apertures occur transversely around the stem. Interspaces are rounded and bear a single row of small acanthopores and at the cell angles are rather prominent blunt megacanthopores. The axial tube measures .20 mm. in diameter and the zooecial tubes diverge from it at an angle of about 28 degrees.

This species rather resembles *R. simulatum gracile* in size and general measurements of the apertures but is distinguished by the thicker interzooecial ridges, the prominent megacanthopores, and by the greater angle of divergence of the zooecia. Longitudinally the apertures are more closely crowded than in any of our other species.

RHABDOMESON TENERUM Moore, n. sp.
Plate 17, figs. 15, 16; text figs. 5 *a, b*

Zoarium very slender, cylindrical, about .6 to .7 mm. in diameter, apertures .2 to .23 mm. long by .05 to .08 mm. wide. Interspaces broad, flat-topped, the sloping area around the apertures being very narrow. Longitudinally, five apertures occur in a space of 2.65 to 3.15 mm.; diagonally there are five apertures in 1.63 mm., and horizontally five in about .85 mm., although in some specimens the horizontal ranges are very poorly developed. Transversely there are 16 alternating ranges around the stem. Rather short blunt acanthopores of two orders, large and small, occupy the interspaces. The diameter of the axial tube is .4 mm. and the zooecia diverge at an angle of 11 to 12 degrees.

This form is distinguished from other species in our collection by the elongate apertures and flattened interspaces, by the diameter of the axial tube, and the angle of the zooecia.

RHABDOMESON FILUM Moore, n. sp.
Plate 17, fig. 5; plate 18, figs. 6, 7; text figs. 5 *8*

Zoarium a very slender delicate stem about .45 mm. in diameter. Zooecial apertures elongate-elliptical to lanceolate, well rounded at the posterior margin but more or less pointed at the anterior end,

length about .28 mm., width .09 to .14 mm. The apertures are arranged in distinct longitudinal and diagonal intersecting series, five occurring longitudinally in a space of 2.5 to 2.8 mm. Interspaces very narrow, surmounted by a row of tiny acanthopores which project somewhat strongly, the junction of the apertures being marked by a longer and larger acanthopore. The axial tube is round, .1 mm. in diameter. The zooecial tubes diverge from it at a very narrow angle with almost no outward inflection on approaching the surface. Accordingly the anterior part of the apertures is extremely shallow while the depth at the posterior margin of the aperture represents the diameter of the zooecial tube.

This species is readily distinguished from other representatives of the genus with which we are acquainted by its very delicate tenuous form and the very low angle at which the zooecial tubes approach the surface.

Genus RHOMBOCLADIA Rogers

1900. ROGERS, Kans. Univ. Quar., vol. 9, no. 1 (A), 11.

Rogers' description "Zoaria dichotomously dividing stems, poriferous on one side only. Stems compressed, without lateral branches. Zooecial tubes very long, with thin walls. Arising near the reverse side, they are first recumbent, then curve upward and meet the poriferous surface at an angle of about 60 degrees, increasing in size and the walls becoming thicker at the same time. Primitive portions of the zooecia elongate subquadrate in outline. Apertures sub-elliptical, with ridge-like interspaces, arranged in several alternate longitudinal ranges; also in diagonally intersecting series. The reverse surface is smooth. Mesopores and hemisepta apparently absent.

The systematic position of this genus is somewhat in doubt. The obverse side of the specimens closely resembles that of some species of *Rhombopora,* but the zooecial tubes and the form of the zoarium are quite different from that genus. It is provisionally referred to the Acanthocladiidae."

The distinctive characters of these interesting little bryozoans makes recognition easy. Rogers' material consisted of specimens in which the obverse faces were embedded in a limestone matrix, and he was, consequently, dependent to a considerable extent on thin sections for part of his information concerning the nature of the zoaria. Unfortunately his figures for *R. delicata,* the genotype and only known species, are so generalized and in part inaccurate that

the structure and typical appearance of the genus has been very inadequately known. Nevertheless it is strange that in the nearly thirty years since the original description there have not been numerous records of its occurrence, for the writer has found it not uncommon in Pennsylvanian strata at widely differing stratigraphic horizons in Texas, Oklahoma, and Kansas, and two of his students have found it in collections made by them, respectively in eastern Kansas and St. Louis County, Missouri.

The generic diagnosis of Rogers may be supplemented and modified as follows: The axis of the vestibule and of the outer thick-walled portion of the zooecia is much more nearly normal to the zoarial face than indicated in the original description. Acanthopores of two sizes are abundant in the thick-walled portion of the obverse face. The megacanthopores are distributed at the angles between the cells so that commonly there are six megacanthopores surrounding each aperture. The micracanthopores are abundant, forming a closely crowded zone of more than one row surrounding the apertures. Internally a thin curved diaphragm, convex upward, commonly occurs somewhere near the mid-length of the zooecial tubes. Hemisepta are well developed, the superior being much stronger and more definite than the inferior. The inferior hemisepta, which are rather weak, are located slightly nearer the aperture than the superior. The reverse surface of the zoarium is covered in well preserved specimens by a thin theca which bears minute crenulations or growth lines that swing forward in the direction of zoarial growth in a deep U-shaped loop.

As suggested by the similarity of the obverse face to species of *Rhombopora* and other representatives of the Rhabdomesontidae, the internal structures observed clearly indicate that *Rhombocladia* belongs in this family.

RHOMBOCLADIA DELICATA Rogers
Plate 17, figs. 26-32

1900. ROGERS, Kans. Univ. Quar., vol. 9, no. 1, 12, pl. 1, figs. 1, 1*b*.

Rogers' description "Zoarium a long slender compressed stem, dividing dichotomously at different intervals. Stems subacutely elliptical in cross section, .7 to .8 mm. wide and .4 mm. thick. Zooecia in about eight alternating ranges, also arranged in regularly intersecting series. Apertures subelliptical, with ridge-like interspaces, giving them the rhombic or hexagonal appearance of the apertures

of *Rhombopora*. Measuring longitudinally five apertures appear in a space of 2 mm., and four in 1 mm. measuring diagonally. Acanthopores of small size present at the cell angle. Reverse side smooth. The primitive portions of the zooecia are usually visible on both sides. The specimens usually adhere to the matrix on the obverse side."

Several dozen free specimens corresponding essentially with the description given by Rogers, and with internal structure as indicated in the discussion of the genus, are contained in our collection. The interspaces between the apertures are commonly rounded and are marked by the micracanthopores or small granules. Stronger spines at the cell angles mark the location of the megacanthopores. At the margins of the obverse face the edge of the thecal wall covering the reverse forms a narrow slightly irregular lip that incloses the poriferous side. Cross sections of the branch make evident the fact that the zooecia arise from this basal lamina. The number of ranges of apertures is variable, from six to eight.

Family CYSTODICTYONIDAE Ulrich

Genus CYSTODICTYA Ulrich

CYSTODICTYA FORMOSA Moore, n. sp.

Plate 18, figs. 4, 12, 13

Zoarium a slender bifurcating stipe, subcircular or slightly elliptical in section, showing a more or less acute angle along the narrow non-poriferous margins but evenly rounded on the wide non-poriferous margin. The width and thickness of a typical specimen are .96 and .72 mm. respectively. Zooecial apertures in linear series parallel to the margins of the stipe or slightly oblique to the margins where a new row of apertures is introduced on the narrow non-poriferous side and the row on the other side ceases. Normally there are four ranges of apertures on each face of the zoarium. The apertures in the range bordering the wide non-poriferous margins are normally the larger, commonly measuring about .17 mm. in length by .115 mm. in width. A more or less elevated, commonly incomplete peristome surrounds the apertures. A distinct lunule or portion of the peristome curved to shorter radius occurs uniformly on the side of the aperture toward the wide margin, and this is extended above the general surface of the zoarium so that the apertures are all directed toward the narrow non-poriferous margin. Seven to eight apertures occur in 5 mm. in the row bordering the wide margin, and in the

row bordering the narrow margin there are ten and a half to twelve apertures in 5 mm. Most typically these counts are 7½ and 11, respectively. Obliquely the apertures form irregular transverse rows. Apertures adjacent to the narrow margin are distinctly smaller than average. Surface finely granular. The edge of the mesotheca forms a distinct, very narrow, granuled ridge on both margins.

This species is probably most closely related to *C. anisopora* Condra which agrees in general dimensions of the zoarium, but differs in having normally five rows of apertures on each face, in slightly wider spacing of the apertures in all ranges, and in the development of prominent, transverse oblique ridges. In *C. formosa* the transverse rows of elevated peristomes are more or less common in parts of the zoarium, but they do not form elevated ridges. *C. inaequimarginata* Rogers has more closely spaced apertures which appear to differ in shape, and development of peristomes. *C. formosa* is very abundant in our collection.

CYSTODICTYA FORMOSA var. ROBUSTA Moore, n. var.
Plate 18, figs. 14, 29-31

This variety, agreeing in form and general measurements with other representatives of this species, is distinguished by the larger size of the stem and the robust, more or less prominently elevated zooecia arranged distinctly in transverse ridge-like rows. The dimensions of a typical specimen are: width, 1.15, thickness, not including elevated peristome, 1.0 mm., thickness, including projecting peristome, 1.3 mm. About 8 apertures occur in 5 mm. in the range next to the wide margin, and 12 next to the narrow margin.

CYSTODICTYA FORMOSA var. OCULIFERA Moore, n. var.
Plate 18, figs. 15, 16

A form distinguished by unusually large apertures differing somewhat in shape from those of the average is designated as variety *oculifera*. Width of stem 1.0 mm., thickness, not including peristome, .72, including peristome .92 mm. There are four rows of apertures, 6.3 in 5 mm. in that next to the wide non-poriferous margin and 11 in the same space along the narrow margin. The apertures adjacent to the wide margin measure .23 by .18 mm., those next to the narrow margin .26 by .14 mm. The space between apertures on opposite sides of the zoarium at the narrow margin is .14 mm. and on the wide margin about .9.

CYSTODICTYA FORMOSA var. LINEARIS Moore, n. var.
Plate 18, figs. 17-19

The general form and arrangement of zooecia in this variety accord with the description just given. Commonly the stipes are somewhat more slender, there are in most cases three instead of four ranges, and the longitudinal rows are accentuated by the presence of more or less distinct narrow ridges running longitudinally between

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EXPLANATION OF PLATE 18

FIGS. 1–3, 8–11.—*Goniocladia grahamensis* Moore, n. sp. 1, transverse section of two contiguous branches, showing sharp obverse and rounded reverse faces, ×10; 2, tangential section about half-way down in the zoarium, showing mesotheca and recumbent zooecial tubes, ×10; 3, longitudinal section, parallel but slightly to one side of the mesotheca, ×10; 8, obverse view of a fenestrule, a cotype, ×10; 9, side view of a fragment showing three ranges of apertures, the obverse side of the branch to the left, ×10; 10, obverse view of a fragment, ×10; 11, reverse side of the fenestrule shown in 8, ×10.

4.—*Cystodictya formosa* Moore, n. sp. Tangential section, normal to plane of mesotheca, ×10.

5.—*Rhabdomeson bellum* var. *sociale* Moore, n. var. A cotype, ×10.

6, 7.—*Rhabdomeson filum* Moore, n. sp., var.? Two specimens smaller than average, possibly distinct species, ×10.

12, 13.—*Cystodictya formosa* Moore, n. sp. 12, obverse view, from the narrow non-poriferous margin, ×10; 13, reverse view, from the wide non-poriferous margin, ×10.

14, 29–31.—*Cystodictya formosa* var. *robusta* Moore, n. var. 14, obverse view, ×10; 29, side view, ×10; 30, obverse view, ×10; 31, reverse view, ×10.

15, 16.—*Cystodictya formosa* var. *oculifera* Moore, n. var. 15, obverse view, ×10; 16, reverse view, ×10.

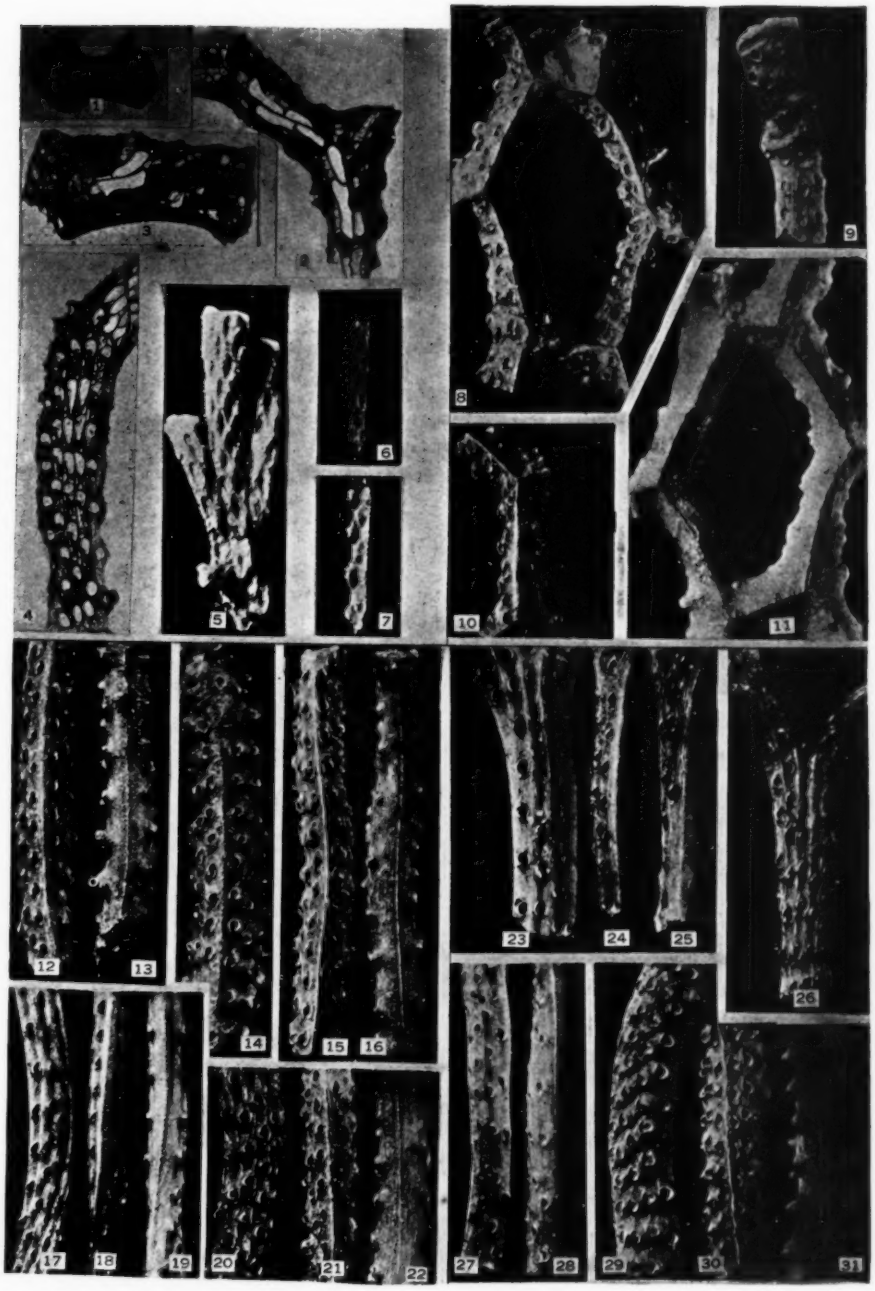
17–19.—*Cystodictya formosa* var. *linearis* Moore, n. var. 17, side view, ×10; 18, obverse view, ×10; 19, reverse view, ×10.

20–22.—*Cystodictya formosa* var. *striata* Moore, n. var. 20, side view, ×10; 21, obverse view, ×10; 22, reverse view, ×10.

23–25.—*Cystodictya lophodes* Condra. 23, side view, ×10; 24, obverse poriferous margin, ×10; 25, reverse view, from the wide margin, ×10.

26.—*Cystodictya lophodes* Condra, var. Side view of a bifurcating stem, ×10.

27, 28.—*Cystodictya modesta* Moore, n. sp. 27, side view, ×10; 28, reverse and side view.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the rows of apertures. The apertures are also arranged in irregular transverse rows, but the lack of elevated peristomes subordinates this feature. The variety is common and rather easily distinguished.

CYSTODICTYA FORMOSA var. STRIATA Moore, n. var.
Plate 18, figs. 20-22

Several specimens are grouped here which show characters resembling the varieties *robusta* and *oculifera* on one hand and variety *linearis* on the other. This group is distinguished by the comparatively large size of the branches, a typical specimen measuring, width 1.1 mm., thickness .72 (including projecting peristome .92 mm.), by the comparatively large apertures bearing distinct lunules, and by the development of narrow crested longitudinal ridges; elevated transverse ridges are not present. Next to the wide margin there are 7.8 to 8 apertures in 5 mm., and adjacent to the narrow margin 10.5 to 11.5 in 5 mm.

CYSTODICTYA LOPHODES Condra
Plate 18, figs. 23-25, 26

1902. *Cystodictya lophodes* CONDRA, Am. Geol., vol. 30, p. 352, pl. 35, figs. 6, 7.

1903. *Cystodictya lophodes* CONDRA, Nebr. Geol. Survey, vol. 2, pt. 1, p. 106, pl. 21, figs. 6-9. Coal Measures, Roca, Nebraska.

Zoarium a compressed elliptical bifurcating stipe, the angles of the bifurcating branches more than 90 degrees, width about 1.0 mm., thickness .6 to .7 mm. Non-poriferous margins of slightly unequal width, the narrower one acute angled and the wider somewhat rounded. The distance between zooecia on opposite sides of the zoarium is about .17 mm. at the narrow margin and .63 at the wide margin. Apertures subcircular to elliptical, surrounded by a continuous, slightly elevated peristome which in most cases shows only a suggestion of a lip on the side toward the wide non-poriferous margin. Average dimensions in the row adjoining wide margin are, including peristome, .29 by .21 mm., inside measurements .2 by .14 mm.; near the narrow margin, including peristomes, .26 mm. by .2 mm., inside .14 by .11 mm. There are normally four longitudinal ranges of zooecia, separated by low but distinct ridges; 7.2 to 7.6 apertures occur in 5 mm. on the side toward the wide margin, and 9.3 in 5 mm. on the side toward the narrow margin. The distance between ridges is .24 mm. The wide margin and parts of the shal-

low canals between the ridges are marked by irregularly curving narrow ridges.

In Condra's specimens from the Elmdale shale of Nebraska the non-poriferous margins are described as small and approximately equal and the spacing of the apertures in each row is said to be about eight in 5 mm. However his figure (Neb. Geol. Survey, vol. 2, pl. 21, fig. 9) shows a range of 7.6 apertures in five mm. on the side presumably slightly wider to 9.2 on the narrower side.

A specimen which is possibly a variety of this species has a width of 1.0 mm., thickness .57 mm., apertures .23 by .14 mm. to .16 by .13 mm., the larger adjacent to the wider non-poriferous margin which is not much wider than the narrow margin. Seven apertures occur in 5 mm. in the row next to the wider margin and eleven in the row next to the narrower margin. The apertures show development of a distinct lunule.

CYSTODICTYA MODESTA Moore, n. sp.
Plate 18, figs. 27, 28

Zoarium a slender bifurcating branch, the angle between the branches about ninety degrees. Width .63 mm., thickness .51 mm., non-poriferous margins unequal. Apertures small, the largest in the row adjacent to the wide margin .14 by .085 mm., 7.3 in 5 mm. longitudinally. The smallest are in the range adjacent to the narrow margin, measuring about .05 by .057 mm., 10.5 in 5 mm. Longitudinally the apertures are separated by 4 to 6 times their diameter. The distance between zooecia on opposite sides of the zoarium at the narrow margin is .13 mm. and at the wide margin it equals the maximum thickness of the branch. The arrangement of the apertures in longitudinal series is accentuated by the development of inconspicuous ridges. There are also irregularly oblique series of apertures. There are normally four ranges on each side of the zoarium.

In its measurements and in the small size of the apertures this species is unlike other forms known to us.

Genus GONIOCLADIA Etheridge, Jr.

GONIOCLADIA GRAHAMENSIS Moore, n. sp.
Plate 18, figs. 1-3, 8-11

Description of this species is based upon about three dozen fragments in which there are but two complete fenestrules. Like the

other bryozoans from the Eastland County locality, the material is beautifully preserved and reveals satisfactorily all characters except the general form of the entire zoarium. The branches are appressed, subpyriform in cross section, thicker than wide. Measurements of the width show a range of .5 to 1.0 mm., the average being about .7 mm.; the thickness ranges from .85 to 1.4 mm., the average being 1.0 mm. The poriferous or obverse face of the branches is sharply carinate, but the zooecia on the two sides of this sharp edge are in some cases so close that they are almost in contact. Zooecial apertures typically in three rows on each side of the median keel, but locally there are two or occasionally four rows. Apertures moderately large, those in the top row about .11 mm. wide by .14 mm. long, those in the bottom range .17 by .185 mm. The lower margin is provided with a projecting lip so that the aperture is directed upward. The non-poriferous side is angular to rounded and carries a distinct linear keel which is only slightly less sharp than that on the other side. Surface minutely granulose.

Except for the mode of zoarial growth the resemblance of *G. grahamensis* to asscciated species of *Cystodictya* is striking. The form of the apertures, the character of the narrow poriferous and the wide non-poriferous margins and internal structure are, of course, strongly cystodictyid. The carinae of *Goniocladia* mark the edges of the mesotheca. The chief distinguishing figure of the genus is that the bifurcations of the branches take place in a plane at right angles to that of the mesotheca, instead of in its plane as in *Cystodictya,* and the branches inosculate at subregular intervals. As a result the narrow poriferous side of the branch is always directed toward one side in *Goniocladia,* whereas in the branch of *Cystodictya* the wide non-poriferous margin occurs on the inside of the angles of the bifurcating branches and the narrow poriferous margin on the outside; thus one of the branches is inverted with respect to the main stem below the branching.

G. grahamensis is readily distinguishable from *G. americana* Girty by its smaller size and if Girty's conclusions concerning the lack of a distinct carina on the poriferous side are correct there is a marked difference in this character. From *G. indica* Waagen and Pichl from India and the genotype *G. cellulifera* Etheridge jr., from Scotland, our species differs in the lack of striations on the reverse, in size, and so far as can be determined, in shape of the fenestrules. Girty's species was described from the upper Permian of West Texas. *G. grahamensis* is the first record of this interesting genus from the Pennsylvanian

rocks of North America. The occurrence of so distinctive a form in widely separated parts of the world is significant as regards intercontinental shallow water connection in late Carboniferous time. Bassler[1] has recognized the genus in the Permian of Timor, Dutch East Indies. It is thus known at present from Scotland, India, the East Indies and Texas.

[1] Personal communication.

MARINE SHELLS IN ASSOCIATION WITH LAND PLANTS IN THE UPPER CRETACEOUS OF GUATEMALA

By L. W. STEPHENSON and E. W. BERRY

In January, 1928, Mr. S. A. Grogan, Chief Geologist of the Mexican Gulf Oil Company, Tampico, Mexico, submitted to the writers a small collection of fossils made by Mr. L. G. Putnam, one of the geologists of that company, at a ranch called Chipaxché, on the road from Cajabón to Chahal, in the District of Verapaz, in the north-central part of Guatemala; the locality is approximately 74 kilometers north, 80 degrees east of Coban, and 157 kilometers north, 73 degrees east of Guatemala City, and is accessible by animal transportation only from Estor on Lago Izabal, or from Coban.

The District of Verapaz is situated north of the continental divide which, south of the fossil locality here described, is composed mainly of metamorphic and intrusive igneous rocks. The fossil locality is in the midst of a rugged mountainous area, the mountains of which are composed mainly of limestones of Lower Cretaceous age, and the intervening valleys of which are underlain by shales, sandstones, and conglomerates of Eocene age. The fossils demonstrate that there are also some rocks of Upper Cretaceous age. The writers have not been furnished with detailed information about the local section from which the fossils were obtained.

The collection is especially interesting because of the close association in the same bed of marine shells and land plants. Although theoretically it is to be expected that land plants will float out into the ocean where they will become water-logged and sink to the bottom, and in this way become preserved as fossils in association with the remains of marine organisms, actually well preserved plants are sel-

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dom found in such association. For this reason it appears desirable to put on record a description of this occurrence.

The rock containing the fossils is a pure chalky limestone which splits along parting planes in thin, platy, more or less curved layers and was evidently deposited in a nearly clear, shallow sea, probably not far off shore, in water deep enough to be only slightly agitated by the waves.

In the following paleontologic discussion the remarks on the marine shells are by L. W. Stephenson and those on the plants, including the description of a new species, are by E. W. Berry.

The marine shells include two fairly well preserved imprints and numerous fragmentary imprints of bivalve mollusks belonging to the genus *Inoceramus*. The smaller of the two shells is subcircular in outline, moderately convex and ornamented with rather coarse concentric ribs. It appears to be closely related to, if not identical with, *Inoceramus deformis* Meek, a species which is common in the Austin chalk of Texas and in the Niobrara limestone of the Western Interior of the United States. The larger specimen is more elongate, somewhat oblique, and rather coarsely ornamented concentrically. It has been mechanically pressed slightly out of shape so that its exact original outline can not be determined, and it has not been possible, therefore, to identify it precisely with any previously described species. However, it is closely related to, and may be specifically identical with, specimens of *Inoceramus* from the Austin chalk.

Although these shells do not afford conclusive evidence as to their exact stratigraphic position, they are of Upper Cretaceous age, and both of the well preserved specimens suggest the Austin age of the containing bed, a correlation which is in harmony with Mr. Putnam's conclusions.

The fossil plants include several twigs of a coniferous tree and the fertile pinnule of a fern. They are of very great interest in connection with their geographical occurrence and also in the illustration they afford of stratigraphic methods and paleobotanic practice. The coniferous twigs are of a type which most paleobotanists would unhesitatingly refer to what has been recorded from a very

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EXPLANATION OF PLATE 19

FIG. 1.—*a*, *Inoceramus* cf. *I. deformis* Meek. *b*, *Dicksoniopsis conipteroides* Berry.

2.—Twig of *Araucarites* sp. and fragment of *Inoceramus* sp.

large number of Mesozoic localities and horizons under the name *Sequoia reichenbachi* (Geinitz) Heer. Nearly everyone, however, has recognized that this species was a composite one and that only those occurrences in which cones were attached to the leaf-bearing twigs could they be definitely related to *Sequoia*.

This quondam species was first described from Saxony by Geinitz in 1842, who christened it *Araucarites reichenbachi* because he thought it was related to the genus *Araucaria*. In 1871 Heer described a second and similar species from the same horizon in Saxony and called it *Geinitzia formosa*. *Geinitzia* has different cones, but the foliage is essentially the same as that of *Sequoia reichenbachi* and it is probable that the foliage in both cases was the same, although many students have thought that there were differences in the length, slenderness, and curvature of the individual leaves. Both came from a horizon whose age is subject to differences of opinion but which is either Santonian or Campanian. *Geinitzia formosa* has also been recorded from a large number of localities and horizons and is also probably a composite species.

We may sum up by saying that both *Sequoia* and *Geinitzia* can be recognized by their cones, but that the foliage in the absence of cones can not be distinguished with any degree of certainty. Therefore from the foliage alone the Guatemalan material can not be precisely identified, and the question as to what to call it can be settled only through certain geographical considerations.

The genus *Araucaria* makes its appearance in the Jurassic and is clearly cosmopolitan in the Cretaceous. Even in the Tertiary it is still found in North America and Europe. Since the Tertiary its range has gradually become restricted to regions of heavy rainfall in southern Brazil, southern Chile (with two species and possibly a third in mountains of Bolivia), and seven species found in New Caledonia, Queensland, New South Wales, New Guinea, New Hebrides, and Norfolk Island.

The Guatemalan occurrence very evidently represents part of the cosmopolitan range of Upper Cretaceous Araucarias. Its occurrence is in a region where *Sequoia* would not be expected. We would refer

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EXPLANATION OF PLATE 20

FIG. 1.—Twig of *Araucarites* sp. with fragment of *Inoceramus* sp.
2.—Twig of *Araucarites*.
3.—*Inoceramus* sp.

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the Guatemalan species to the genus *Geinitzia* except for the fact that *Geinitzia* is characterized by a definite type of cone, and we do not know the cones in this material. We therefore refer it to the form genus *Araucarites*, as denoting its relationship, and point out that it is probably identical with some but by no means all of the occurrences in other regions that have been called *Sequoia reichenbachi* and *Geinitzia formosa*, and by this token the Guatemalan deposit should probably be correlated with either the Santonian or Campanian substages of the standard Upper Cretaceous section.

The second type of vegetation found in association with the shells of *Inoceramus* is the fertile pinnule of a fern in which the lamina is so reduced as to be practically absent and the pinnule consists of two rows of sporangia.

There is but one family of recent ferns in which this reduction has proceeded in the same way and to the same extent as in the fossil, and that is the family Cyatheaceae, to which most of the existing tree-ferns belong. The modern genus *Dicksonia*, for example, furnishes species practically identical with the fossil. Fertile specimens of fossil ferns are by no means common, and none that has been described in *Dicksonia* or related genera is exactly like the present fossil, the most similar being those of the exclusively Jurassic genus *Coniopteris*.

This does not necessarily mean that the present fossil should be referred to *Coniopteris*, and it certainly is not to be considered as suggesting a Jurassic age for the deposits since ferns with this type of fructification have been in existence from the Jurassic to the present and are probably more abundant at present than at any time during the past.

Neither does it seem proper to refer the Guatemalan fern to any existing genus of the family Cyatheaceae until we know more about its other features, and it may therefore be called *Dicksoniopsis coniopteroides*, which indicates sufficiently its botanical relationship.

ACTINOSIPHON SEMMESI, A NEW GENUS AND SPECIES OF ORBITOIDAL FORAMINIFERA, AND PSEUDORBITOIDES TRECHMANNI H. DOUVILLÉ

By THOMAS WAYLAND VAUGHAN
Scripps Institution of Oceanography, University of California,
La Jolla, California

ABSTRACT

This paper presents a description of *Actinosiphon semmesi*, a new genus and species of orbitoidal foraminifera, from probably the lower Eocene Chicontepec formation in a well at El Cristo, near Tempoal, Mexico, at a depth of 2785-90 ft., and a redescription of *Pseudorbitoides trechmanni* H. Douvillé, from the upper Cretaceous of Green Island, Jamaica.

ACTINOSIPHON Vaughan, new genus

Genoholotype *Actinosiphon semmesi* VAUGHAN.

Test lenticular, with a single layer of equatorial chambers and well developed lateral chambers. Pillars and terminal small papillae present. Embryonic apparatus of the megalospheric form consists of a rather large subspherical initial chamber, followed by a smaller chamber whose longer diameter is parallel to the circumference of the first chamber. The latter chamber is followed by about eleven other chambers which entirely encircle the first two chambers and outside this circle there are several other chambers opposite chamber no. 3. The equatorial chambers tend to form radial rows; roofs and floors perforate. Each chamber communicates by a medianly placed stolon with the adjacent proximal and distal chamber of the same row. Communication with chambers of adjacent rows by means of stolons at the sides of the chambers. There are no canals.

The name of this genus is taken from the stolon passages between chambers in the same row.

ACTINOSIPHON SEMMESI Vaughan, n. sp.
Plate 21, figs. 1-3

Test small, robustly lenticular, surface strongly papillate. Diameter of megalospheric form about 1.5 mm.; thickness 0.5 mm., about one-third the diameter. The papillae range from 40 to 80μ thick, larger over the center, with radiating plates around their edges, and about their own diameters apart. There are faint radial surface markings.

The embryonic apparatus consists of a large subspherical chamber about 160 by 185μ in diameter, on one side of which is a chamber 112μ long and 64μ across, the elongation parallel to the circumference of the first chamber. The second chamber is followed by a chamber about 190μ long and 45μ wide perpendicular to its long axis. There is an indentation in the outer wall of this chamber and it may have been divided into two chambers. One end of it laps on the second chamber and for the rest of its length it extends around the periphery of the initial subspherical chamber. The last described chamber is followed by ten chambers which, with the third chamber, entirely surround the first two chambers. One of the ten chambers is small and lies at the opposite end of the second chamber from the third chamber. Outside this circle of chambers, opposite the third chamber, are about five chambers similar to those in the circle, and surrounding the entire complicated embryonic apparatus are the usual equatorial chambers. The different embryonic chambers and their arrangement are better presented by the figure based on a photograph (pl. 21, fig. 1) than by a description. Emphasis needs to be placed on the fact that the second chamber is not reniform. The walls are thick and perforate.

The equatorial chambers are polygonal, predominantly hexagonal in plan. Although outwardly convex intersecting curves can be recognized in places, there is a pronounced tendency for the chambers to occur in rows. There is considerable variation in the size of the chambers but a usual radial diameter between the middles of the bounding walls is 45μ, transverse diameter may be slightly the longer. The walls are relatively thick, 15μ being a common thickness.

The equatorial chambers communicate with the lateral chambers through the roofs and floors by means of perforations which measure from about 1.5 to 2.5μ across. Each chamber within the equatorial layer communicates by means of an aperture, about 7μ across, with a chamber on its inner and one on its outer side. The apertures are near the middle of the outer curvature of the chamber walls,

where the walls may be thickened to as much as 20μ. There are also passages at the sides of the chambers and communication with chambers of adjacent rows is through them. There is no hint of any canal system.

The following description of a vertical section is based on a specimen that is broken on one edge. One half its diameter is about 0.90 mm., diameter of the entire specimen was probably about 1.8 mm. Thickness about 0.5 mm. From the appearance of the embryonic chambers it seems that the specimen has been slightly crushed.

The thickness of the equatorial layer at the edge of the embryonic chambers is about 35μ, the roofs and floors ranging from 5 to 10μ in thickness. At the periphery the thickness of the layer is about 55μ, with roofs and floors about 10μ thick. An account of the perforations of the roofs and floors has been given in describing the horizontal section. The distal wall of a chamber is convex toward the periphery, and is of fibrous structure, but except the apertures above noted it seems to be without perforations. Several of the distal walls show a distally directed median thickening of as much as 15μ, about double the thickness of the adjacent other parts of the wall. Most, if not all, of such thickenings appear to be traversed by a radially directed channel. One of them, that is very well defined and is 5μ across, appears to be a stoloniferous passage between two chambers in the same radial series. Each equatorial chamber is formed with its own roof, distal wall, and floor, on the distal side of a previous chamber. There is a joint or suture between the roof and floor of the later and those of the earlier chamber, and there may have been communication along the joints between the equatorial and the lateral chambers. Apertures for the passage of stolons to an adjacent row of chambers are visible in a number of chambers. The usual number is two, but on the proximal side of one chamber there appear to be four such openings. Their diameters range from about 3.5 to 5μ.

There are about eight layers of lateral chambers over the center of the test, the number decreases to one or two at the periphery. The roofs are perforate and range between 7 and 14μ in thickness. The chamber cavities range between 7 and 17μ in height and between 25 and 50μ, occasionally more, in length. The chamber cavities in general are as tall as the roofs are thick and their ends are rather well delimited. Pillars formed by thickened, alternately overlapping ends of chamber roofs, are well developed, as much as about 40μ thick. In addition to the perforations of the roofs, there was prob-

ably protoplasmic connection between lateral chambers at the ends of the chamber walls.

Locality and geologic horizon.—El Cristo well no. 1, Cantón of Tantoyuca, State of Vera Cruz, Mexico, depth 3785-90 ft., Eocene Chicontepec formation. From the Aguila Company, specimens submitted by Mr. W. S. Adkins.

Cotypes.—U. S. National Museum and the Scripps Institution of Oceanography. The two thin sections figured and described are at the latter institution.

No species closely related to *Actinosiphon semmesi* is known to me. Its greatest generic resemblance is to *Pseudorbitoides,* but it differs from that genus by its single layer of equatorial chambers and the stoloniferous passages through the walls of chambers belonging in the same radial series. There are no radial markings such as there are in *Pseudorbitoides.* The embryonic apparatus may also supply characters of generic significance, but the megalospheric form of *Pseudorbitoides* is not known. The second embryonic chamber is not reniform, as in *Lepidorbitoides.* Except some similarity to *Pseudorbitoides,* there is only family resemblance to the other orbitoids that I have studied.

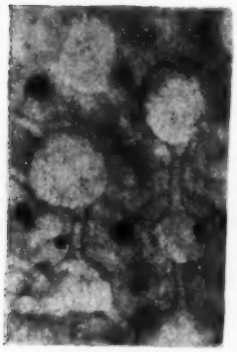
It affords me pleasure to name this species for Dr. Douglas R. Semmes, formerly a member of the geological staff of El Aguila Petroleum Company.

EXPLANATION OF PLATE 21

FIGS. 1, 2, 3.—*Actinosiphon semmesi* Vaughan, n. gen. et sp. Fig. 1, embryonic and equatorial chambers, × about 80; fig. 2, equatorial chambers, × about 360, to show the stolon passages between chambers in the same radial series; fig. 3, vertical section, × about 80.

4, 5, 6.—*Pseudorbitoides trechmanni* H. Douvillé. Fig. 4, section nearly in the equatorial plane, ×33; fig. 5, a few equatorial chambers, × about 80; fig. 6, vertical section of peripheral part of test, × about 80.

(Photographs for all figures by E. M. Thorp. Thin sections for figs. 1, 2, 3, by Donald Gravell; for figs. 4, 5, 6, by Marion W. Moberg.)



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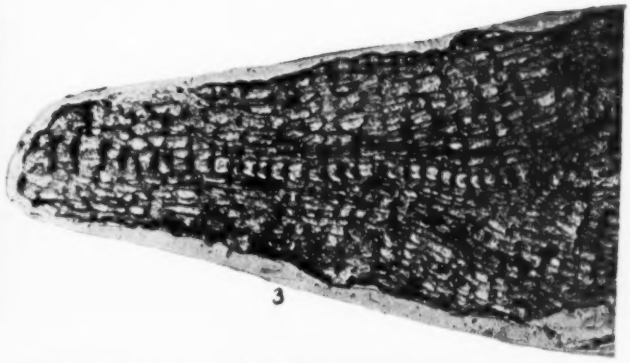

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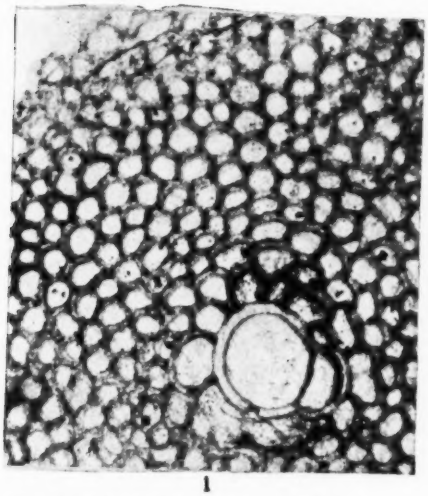

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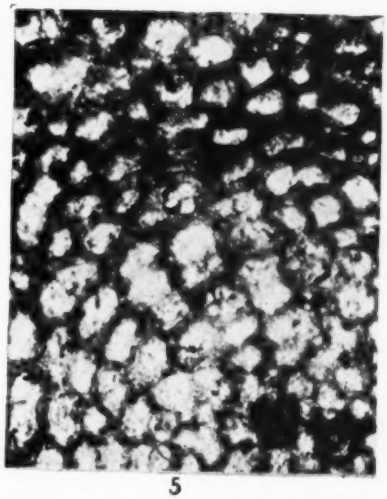

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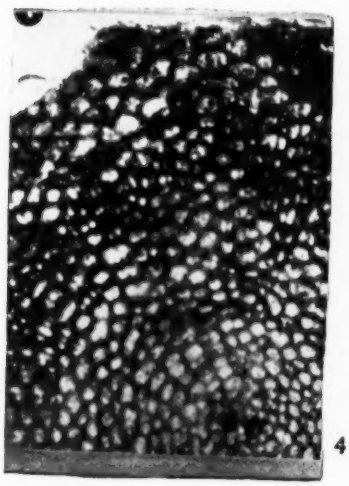

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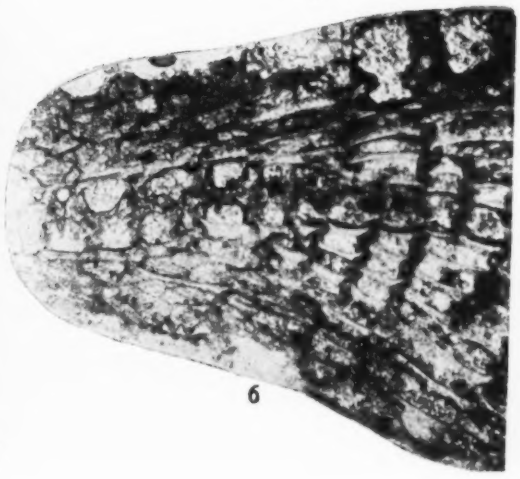

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Genus PSEUDORBITOIDES H. Douvillé

(For reference to the literature, see the following species)

PSEUDORBITOIDES TRECHMANNI H. Douvillé

Plate 21, figs. 4-6

Pseudorbitoides trechmanni H. DOUVILLÉ, France Soc. géol., C. R., 1922, p. 203; France Soc. géol., 4th ser., vol. 23, 1923, p. 369, figs. 1, 2.

Douvillé says (1923) above):

"J'ai signalé à la Jamaïque sous le nom de *Pseudorbitoides trechmanni* (fig. 1, 2) de petits échantillons de 5 millimètres environ de diamètre présentant la structure générale des *Orbitoïdes*, mais avec une couche équatoriale formeé de plusiers couches de logettes, comme dans *Omphalocyclus*. La disposition en spirale des premières loges est très marquée; les logettes voisines d'un même cycle sont souvent un peu écartées, il en résulte quelles se disposent en files rayonantes."

Dr. C. T. Trechmann has kindly sent me a few specimens which he picked off a specimen of *Barrettia* from Green Island, Jamaica, and these have served as the basis of a restudy of the genus and species.

Test sublenticular. Diameter of an apparently microspheric specimen, between 3.5 and 4 mm., thickness about 1.2 mm. A few papillae, 100μ thick, over the center. Indistinct radial lines are visible in places on the surface. A smaller specimen has a diameter of about 2 mm., and a thickness of about 0.75 mm.

A horizontal section of a specimen, about 3 mm. in diameter, shows a centrally situated initial spiral, the beginning chambers of which are indistinct. The equatorial chambers are rather irregular in shape, but in general they are polygonal, many are subhexagonal, the radial somewhat less than the transverse diameter, with a tendency to form radiating rows. Above the chambers are radiating lines, a line over or near the bounding walls of the rows and in places, at least, two lines are over the chamber cavities. The significance of these lines was not ascertained. A common approximate size of the chambers near the center is radial diameter, 45 to 53μ; transverse diameter, 75 to 90μ, or somewhat more. The walls range from about 10 to 15μ thick. The perforations of the roofs and floors are small, about 1.5μ across. Communication between the equatorial chambers is by stolons at the sides of the chamber, which communicates with both the proximally and distally placed chambers of adjacent rows. No passages across the chamber walls leading from one chamber to the next in the same row were observed. The thickness of the equatorial layer where it is thinnest is about 60μ. From

the place at which the above measurement was made to where the equatorial becomes double is about 0.78 mm., and there the layer is about 90μ thick. The chambers are double through a distance of about 0.53 mm. to the periphery, where the thickness is about 100μ. Douvillé's figure shows a treble equatorial layer in a specimen he studied. The horizontal partitions that divide the chambers are as much as 26μ thick. The vertical section does not show apertures for stoloniferous connections between chambers, although such openings are shown in the horizontal sections.

The lateral chambers occur in definite tiers with open, relatively large chamber cavities. There are about ten layers over the center, outside of which the number decreases to one or two at the periphery, which is broken and the actual number is not certainly known. The height of the chambers ranges from about 23 to 38μ; length, 135 to 200μ; floors, 10 to 30μ thick, perforate. Between the tiers of chambers there are pillars, on the opposite sides of which the chamber ends alternate in position.

Specimens here described and figured.—Scripps Institution of Oceanography.

SPECIES OF ORBITOCYCLINA, A GENUS OF AMERICAN ORBITOID FORAMINIFERA FROM THE UPPER CRETACEOUS OF MEXICO AND LOUISIANA

By THOMAS WAYLAND VAUGHAN
Scripps Institution of Oceanography, University of California, La Jolla, California

ABSTRACT

Orbitocyclina is a genus of orbitoidal foraminifera, the genoholotype of which is *Lepidorbitoides minima* H. Douvillé from the Upper Cretaceous of Cárdenas, Mexico. *Polylepidina cardenasensis* Galloway is a synonym of *Orbitocyclina minima*. A new species, *O. nortoni*, from the Upper Cretaceous of a deep well in Moorehouse Parish, Louisiana, is described.

INTRODUCTION

The species here described considerably resemble the genus *Lepidorbitoides* and the one that I am making the genoholotype of *Orbitocyclina* was described as *Lepidorbitoides minima* by Prof. H. Douvillé, with whom at one time I not only agreed but also referred to *Lepidorbitoides* the species that I am here designating *Orbitocyclina nortoni*. Continued study resulted in the discovery of stoloniferous apertures in the equatorial chambers, and the examination of lateral faces of the inside of the equatorial chambers failed to reveal any cribriform perforations such as are characteristic of *Lepidorbitoides*. The embryonic apparatus of the megalospheric form differs from that of *Polylepidina*, to which Professor Galloway referred his *Polylepidina cardenasensis*, which is a synonym of Professor Douvillé *Lepidorbitoides minima*. Under the circumstances a new generic designation is necessary.

Genus ORBITOCYCLINA Vaughan

Genoholotype *Lepidocyclina minima* H. DOUVILLÉ.
Orbitocyclina VAUGHAN, Nat. Acad. Sci. Proc., vol. 15, p. , 1929.

The first chamber of the embryonic apparatus of the megalospheric form is subspherical and is followed by a slightly reniform second chamber. These first two chambers are rather similar to the embryonic chambers of *Lepidorbitoides* but are somewhat smaller. The second chamber is succeeded by three or four other chambers which extend around the initial chamber and nearly or entirely envelope it. The entire apparatus suggests a partial initial spiral. The equatorial chambers have curved outer walls and truncate or pointed inner ends, depending on whether the sides of chambers in the same circle do or do not meet. Communication between the equatorial chambers is by means of stoloniferous apertures. Roofs and floors of the equatorial chambers and the roofs of the lateral chambers are cribriform perforate.

Since both Professor Douvillé and I were misled as to the structure of the equatorial chamber walls of the type-species of the genus, supplemental notes will here be made on that subject. In both vertical and horizontal sections the walls between the equatorial chambers are composed of three layers, as follows: 1, An outer or distal layer which is finely pectinate, the spaces between the teeth look like minute perforations but they do not pierce the wall; 2, a dark layer, whose color may be due to organic matter, but this supposition has not been verified; 3, an inner layer, which is of very finely fibrous structure. The inner surfaces of the walls of those chambers in which the stoloniferous apertures may be studied exhibit no cribriform perforations.

ORBITOCYCLINA NORTONI Vaughan, n. sp.
Plate 22, figs. 1, 2

Test small, thin, slightly lenticular. Diameter, 3.5 mm.; thickness, about 0.5 mm., slightly more or less. Surface very finely papillate, papillae from 20 to 40μ thick, and about 40μ apart.

Embryonic apparatus composed of five or more chambers. The first chamber measured between the outsides of the walls, is about 55 by 65μ in diameter, and the second chamber is about 55 by 90μ in diameter. The walls are minutely perforate and range from 8 to 15μ in thickness. The first chamber is subspherical, the wall between it and the next chamber being slightly convex toward the center of the larger chamber. The longer diameters of the chambers

are perpendicular to a line joining their centers. The distance across the two chambers through their centers is about 110μ. The third chamber overlaps the partition between the first two chambers, its greater diameter, 90μ, is parallel to a line joining the centers of the first two chambers and its lesser diameter, 60μ, is perpendicular to that line. The third chamber is followed by two slightly smaller chambers. Apparently a ring of chambers extends entirely around the first two. There are indistinct suggestions of an initial spiral.

In horizontal sections the equatorial chambers are diamond (lozenge) shaped or they have curved outer walls, contiguous lateral walls and, pointed inner ends. Near the periphery the radial and transverse diameters are both about 70 to 80μ. Communication between the chambers is by stoloniferous openings.

In a vertical section the equatorial chambers are 38μ tall near the center and increase in height toward the periphery; at a distance of 1.7 mm. from the center the height is 75μ. The roofs and floors are pierced by perforations, between 1 and 2μ in diameter. The state of preservation of the specimens is in general unfavorable for the recognition of the stoloniferous apertures, but they can be seen in a few places and range between 5 and 10μ in diameter.

Over the center of a specimen 0.5 mm. thick there are on each side of the equatorial plane about seven layers of lateral chambers. The number decreases toward the periphery but they are present virtually to the edge of the test, thereby leaving no projecting uncovered equatorial layer. In arrangement and size the chambers are rather regular. A usual height is about 30μ, length from 38 to 75μ. Floors and roofs finely perforate. Small pillars emerge on the surface as the minute papillae already noted.

Locality and geologic horizon.—The Texas Company's Huff well no. 1, Sec. 36, T 23 N, R 7 E, Moorehouse Parish, Louisiana; depth, between 2795 and 2802 ft; Upper Cretaceous. One of the thin sec-

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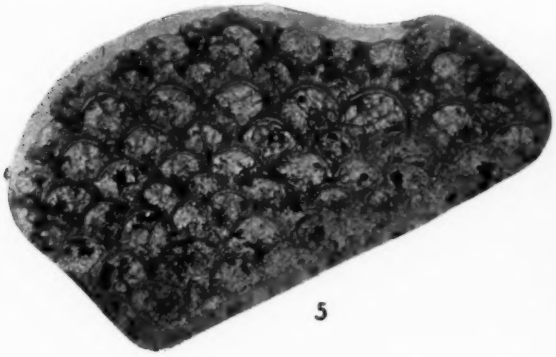
EXPLANATION OF PLATE 22

FIGS. 1, 2.—*Orbitocyclina nortoni* Vaughan, n. sp. Fig. 1, embryonic and equatorial chambers, × about 80; fig. 2, vertical section, × about 32.

3–6.—*Orbitocyclina minima* (H. Douvillé) Vaughan. Figs. 3, 4, embryonic chambers of two specimens, × about 80; fig. 5, equatorial chambers near the periphery, × about 80; fig. 6, vertical sections, ×20.

(Photographs for figs. 1–5 by E. M. Thorp; for fig. 6 by Ernest Schuster. Thin sections, except for fig 6, by Donald Gravell.)



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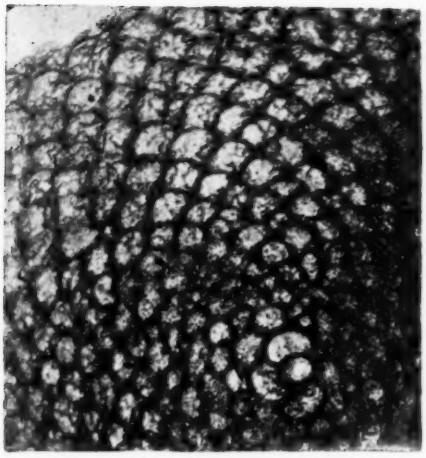

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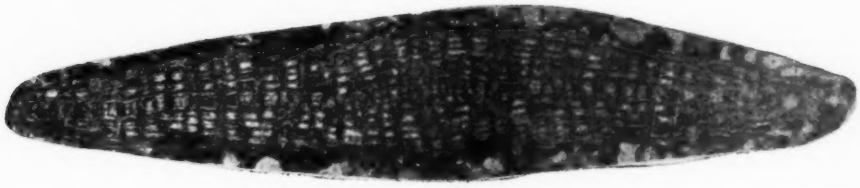

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tions contains a transverse section of a six-ribbed hollow object, the cavity of elliptical cross-section, apparently a species of *Hamulus*. Sample taken by R. D. Norton.

Types.—Cotypes, one specimen on matrix, and two thin sections, deposited in the U. S. National Museum. Paratypes, Scripps Institution of Oceanography.

There is only one American species with which *O. nortoni* needs to be compared, that is the genoholotype, *O. minima* (H. Douvillé) from near Cárdenas, Mexico. It will be discussed in some detail in order to clear away confusion regarding it.

ORBITOCYCLINA MINIMA (H. Douvillé) Vaughan
Plate 22, figs. 3, 4, 5, 6

1923. Description, without name, H. DOUVILLÉ, France Soc. géol., 4 ser., vol. 23, p. 370.
1927. *Lepidorbitoides minima* H. DOUVILLÉ, France Soc. géol., C. R. for Feb. 21, 1927, p. 34, text figs. 1, 2.
1928. *Polylepidina cardenasensis* GALLOWAY, Journ. Pal., vol. 1, p. 302, pl. 51, figs. 1-6.

Specimens of this species have been in my possession for years but I hesitated to publish a name and description of it because of doubt regarding its generic determination.

Douvillé's first notes on it, in connection with his description of *Pseudorbitoides trechmanni*, in 1923, read as follows:

"Tout dernièrement j'ai pu examiner une série d'échantillons du Mexique recueillis il y a plusieurs années par le Dr. Böse sur le ligne du chemin de fer de Tampico à San Luís Potosí, entre les stations Canoas et Cárdenas; ils n'ont guère que 2 à 3 millimètres de diamètre, leur épaisseur est très faible (0.3 mm.), et leur conservation médiocre, de sorte qu'il est très difficile d'obtenir de bonnes préparations minces. Il m'a paru cependant que les premières loges sont disposées en spiral comme dans les échantillons de la Jamaïque, avec seulement une première loge un peu plus grande 50μ au lieu de 30; mais la couche équatoriale ne présente qu'une seule couche de logettes, et deux rangées d'ouvertures; cette couche se diviserait-elle si la taille devenait plus grande?"

The second account was as follows:

"J'ai recu de M. Staub, de Zurich, des échantillons d'Orbitoïdes recueillis par lui dans la région de Tampico. Les plus anciens proviennent du terrain crétacé affleurant, sur la ligne du chemin de fer de Tampico à San Luís Potosí, entre Cárdenas et Canoas (kil. 419-420); ce sont des échantillons minces et de très petite taille (3.5 mm.), présentant un embryon du type *Lepidorbitoides* et également très petit (0.15 mm.); c'est la première fois que ce genre est signalé en Amérique. Ces échantillons, d'après leurs dimensions, sont environ la moitié

des *Lep. socialis* des Pyrénées et les ⅔ des *Lep. minor.* de Maëstricht, on pourrait les appeler *Lep. minima* (fig. 1, 2)."

It appears that the second paper by Professor Douvillé escaped Professor Galloway's attention.

The embryonic apparatus of *O. minima* is of the same type as that of *O. nortoni,* but it is somewhat larger. Two illustrations are here given, pl. 22, figs. 3, 4.

The equatorial chambers are similar except that their radial diameters in comparison with the transverse diameters are relatively shorter. The lateral walls of chambers in the same ring may barely touch, or they may not touch, the intervening space being occupied by the inner end of a chamber of the next outer ring. The communication between the equatorial chambers seems to be exclusively by means of stoloniferous apertures.

The texture of *O. minima* in vertical sections is somewhat coarser and more irregular than that of *O. nortoni* and the papillae on its surface are somewhat larger. The differences in these features are shown in the illustrations. The roofs of the lateral chambers are cribriform-perforate.

Localities of specimens studied.—U.S.G.S. no. 4119, 5 mi. east of Cárdenas, collected by T. W. Stanton; no. 10604, 6.6 km. east of Cárdenas, collected by Tatum and Kearney; no. 10606, 6.8 km. east of Cárdenas, collected by Tatum and Kearney; another collection from the same locality, by L. W. Stephenson.

ABUNDANT FORAMINIFERA OF THE EAST TEXAS GREENSANDS[1]

By JOSEPH A. CUSHMAN and NORMAN L. THOMAS

In the structural and sedimentary basin between the Sabine uplift and the mineral area of Texas, the Mount Selman greensand has a wide distribution both north to south and east to west. It outcrops in Sabine, San Augustine, Nacogdoches, Rusk, Cherokee, Smith, Henderson, Anderson, and Houston Counties east of the Trinity River with its outcrops forming the lines for the main arteries of transportation. Where highways leave greensand outcrops the brownish-green glauconite is transported for surfacing the road beds, a use to which it is well suited. The Mount Selman greensand has a thickness up to one hundred feet and is the thickest and probably the most persistent glauconite bed in the area. It consists of glauconite pellets in a non-calcareous, clayey, iron stained matrix. There is relatively little quartz sand in this bed although the Queen City below and the Cook's Mountain beds immediately above are essentially white quartz sand formations.

In a few places the purity of the bed and the concentration of iron are such that it has been exploited for its iron in times past. Fossils are very abundant in many places and are both mega-fossils and microscopic foraminifera and ostracodes. Due to the insolubility of glauconite, and the comparatively great solubility of shells, and due to the porosity of the greensand bed, fossils are very poorly preserved in most weathered outcrops, and even in outcrops that have the appearance of being relatively fresh.

Above the Mount Selman greensand the Cook's Mountain beds (Nacogdoches) contain glauconitic strata which are fossiliferous. Quartz is abundant, but otherwise the characters are like those of

[1] Published with permission of Chief Geologist of the Pure Oil Company.

the Big Greensand. These beds are included in the Cook's Mountain formation while the Big Greensand is the Mount Selman with its type locality at Mount Selman in Cherokee County. Cook's Mountain is west of Crockett in Houston County, overlooking the Trinity River.

These descriptions are concerned with the most abundant foraminifera of the Mount Selman and Cook's Mountain greensands. Nearly one hundred samples were taken, of which some thirty were very fossiliferous. While the fauna is fairly limited in number of species, the number of individuals is large and the character of the fauna especially of Mount Selman is fairly uniform throughout the Neches-Trinity embayment.

TEXTULARIA cf. MISSISSIPPIENSIS Cushman
Plate 23, figs. 1 *a*, *b*

There is a small species of *Textularia* which is fairly common in the greensands. This is very close to *T. mississippiensis* Cushman known from the Lower Oligocene and Upper Eocene of the coastal region of the United States. Length 0.45 mm.; width 0.25 mm.; thickness 0.12 mm.

Locality.—Three miles north of Bronson, on Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—Cook's Mt. and Mt. Selman greensands of Eocene.

U. S. National Museum Collection No. 371018.

GUTTULINA IRREGULARIS (d'Orbigny)
Plate 23, figs. 2 *a-c*

Globulina irregularis D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 226, pl. 13, figs. 9, 10.

Test short and rotund, subtriangular in cross section, composed of few chambers, usually five or six visible, all of the chambers extending to or nearly to the proloculum but only the last one having the circular and radiate aperture. Length 0.40 mm.; width 0.38 mm.; thickness 0.30 mm.

Locality.—Three miles north of Bronson along Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—In both the Mt. Selman and Cook's Mt. formations of Eocene.

U. S. National Museum Collection No. 371016.

SIGMOMORPHA (SIGMOMORPHINA) PSEUDOREGULARIS Cushman and Thomas, n. sp.
Plate 23, figs. 5 *a-c*

Polymorphina regularis STADNICHENKO (not VON MÜNSTER), Journ. Pal., vol. 1, 1927, p. 231, pl. 38, figs. 18, 19.

Test large; length about twice the width and thickness a little more than half the width; median longitudinal ridge on both sides with sutures sloping backward, both right and left sets beginning at right side of the ridge, the left set crossing the ridge and bending in gentle curve backward while those on the right begin at the right of the ridge and extend backward in a more nearly direct fashion, both sets reaching the periphery and giving the shell only a semi-equitant appearance, the two sides so nearly equal as to give a bilateral symmetry; aperture round, radiate; the apertural end showing four chambers. Length 0.70 mm.; width 0.32 mm.; thickness 0.12 mm.

Locality.—Seventeen and a half miles south of Palestine road on Grapeland road, first creek crossed by fording north of Grapeland, Houston County, Texas.

Range.—Mt. Selman and Cook's Mt. greensands of Eocene.

U. S. National Museum Collection No. 371021.

UVIGERINA PARVULA Cushman and Thomas, n. sp.
Plate 23, figs. 3, 4

Test minute, calcareous, finely perforate, elongate, somewhat triangular in cross section; chambers numerous, distinct, adult ones appearing roughly equi-dimensional; sutures depressed; surface of first three or four coils ornamented with faint longitudinal costae but surface of last adult chambers smooth, last chamber with short cylindrical neck with only slight phialine character; the aperture circu-

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EXPLANATION OF PLATE 23

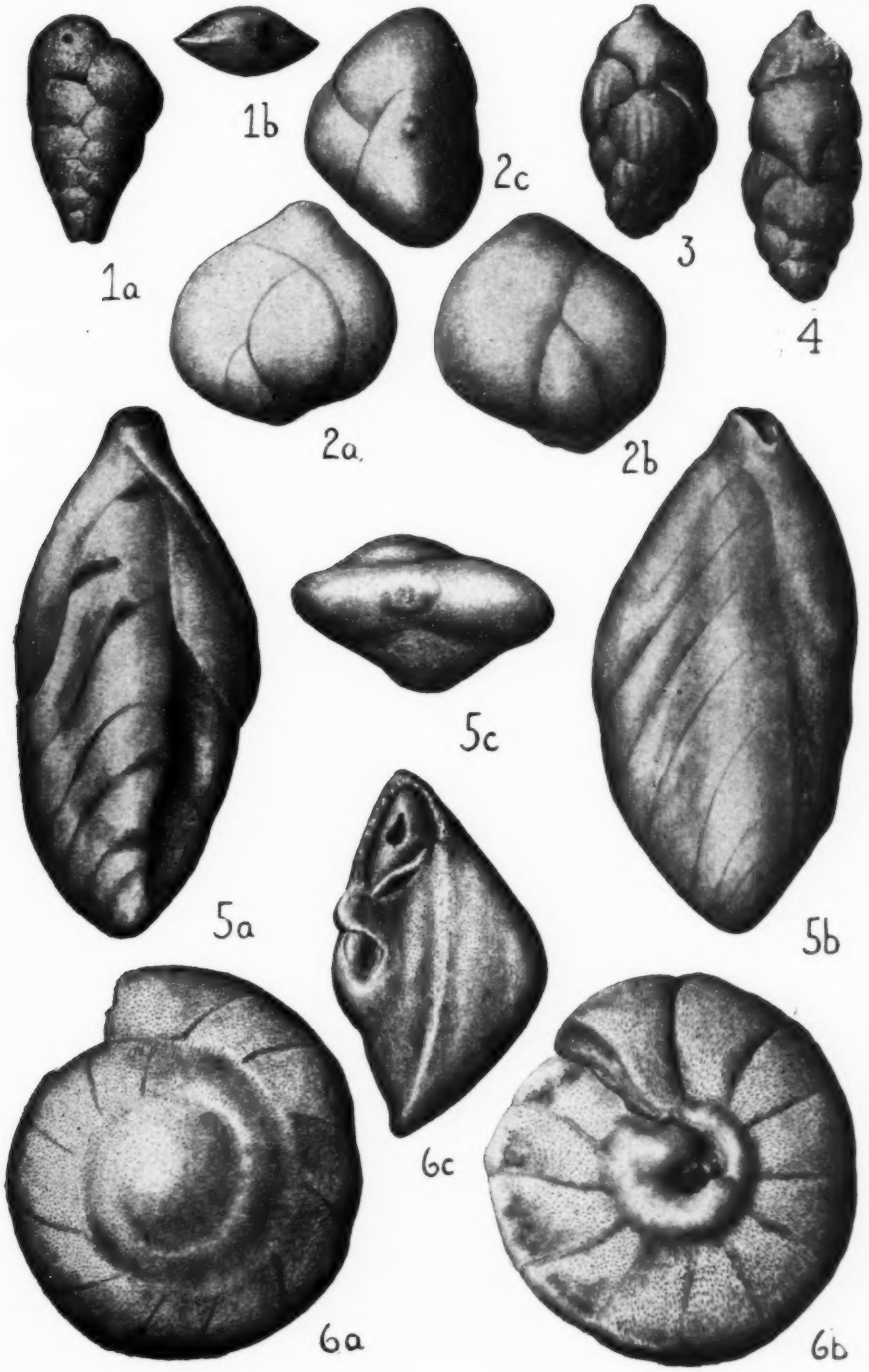
FIGS. 1 *a, b.*—*Textularia* cf. *mississippiensis* Cushman. ×65. *a*, front view; *b*, apertural view.

2 *a–c.*—*Guttulina irregularis* (d'Orbigny). ×65. *a, b*, opposite sides; *c*, apertural view.

3, 4.—*Uvigerina parvula* Cushman and Thomas, n. sp. ×120.

5 *a–c.*—*Sigmomorpha (Sigmomorphina) pseudoregularis* Cushman and Thomas, n. sp. ×50. *a, b*, opposite sides; *c*, apertural view.

6 *a–c.*—*Eponides guayabalensis* Cole. ×65. *a*, dorsal view; *b*, ventral view; *c*, apertural view.


1a
1b
2c
3
4
2a
2b
5c
5a
5b
6c
6a
6b

lar. Length of one specimen 0.22 mm.; width 0.19 mm.; length of another specimen 0.27 mm.; width 0.11 mm.

Locality.—Three miles north of Bronson, on Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—Cook's Mt. greensands, Eocene.

U. S. National Museum Collection No. 371014.

EPONIDES GUAYABALENSIS Cole

Plate 23, figs. 6 *a-c*

Eponides guayabalensis COLE, Bull. Amer. Pal., vol. 14, no. 51, 1927, p. 29, pl. 2, figs. 17-19.

Eponides patelliformis STADNICHENKO, Journ. Pal., vol. 1, 1927, p. 232, pl. 38, figs. 6-8.

Shell comparatively large, calcareous, finely perforate, smooth, biconvex; two coils and a smooth boss showing on dorsal side, and umbilicus and last coil showing on ventral side; periphery rounded; many specimens more convex on dorsal side, but others more convex on ventral side, and others practically equi-convex; sutures slightly depressed; umbilicus surrounded by raised ring; shell without keel, and outline only slightly lobate; aperture, a slit at the base of the last chamber reaching from the ring of the umbilicus nearly to the periphery; secondary aperture in the middle of last septal face in many adult specimens. Length 0.6 x 0.8 mm.; width 0.6 x 0.7 mm.; thickness 0.3 x 0.8 mm.

Locality.—Macune, San Augustine County, Texas.

Range.—Cook's Mt. and Mt. Selman greensands of Eocene.

U. S. National Museum Collection No. 371020.

LAMARCKINA CLAIBORNENSIS (Cushman)

Plate 24, figs. 1 *a-c*

Lamarckina marylandica CUSHMAN, var. *claibornensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 10.

Test calcareous, finely perforate, plano-convex, composed of two and a half coils showing on the convex dorsal side, and last coil and small umbilicus showing on flat ventral side; periphery moderately sharp, circular and not lobate; sutures distinctly limbate on dorsal side giving characteristic ornamentation, sutures practically obsolete on ventral side leaving surface smooth; aperture, a slit reaching from the comma-like umbilicus to the periphery. Length 0.42 mm.; width 0.40 mm.; thickness 0.15 mm.

Locality.—Two miles east of Alto, Cherokee County, Texas.
Range.—Mt. Selman greensand of Eocene.
U. S. National Museum Collection No. 371022.

SIPHONINA CLAIBORNENSIS Cushman
Plate 24, figs. 2 *a-c*

Siphonina claibornensis CUSHMAN, Proc. U. S. Nat. Mus., vol. 72, 1927, p. 4, pl. 3, figs. 5 *a-c*.

Test small, nearly circular, nearly equally biconvex, somewhat compressed, periphery angled, sharply acute, with a very slightly developed keel, lobulate; chambers usually five in the last-formed volution, slightly inflated on the ventral side; sutures distinct, strongly oblique, slightly curved, somewhat limbate on the dorsal side, on the ventral side nearly radial, depressed; wall smooth, very distinctly perforate; aperture elongate, narrowly elliptical, occupying the whole height of the chamber, with a distinct lip but no definite neck. Diameter 0.35 mm.; thickness 0.13 mm.

Locality.—Three miles north of Bronson along Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—Cook's Mt. and Mt. Selman greensands of Eocene.

U. S. National Museum Collection No. 371019.

ASTERIGERINA TEXANA (Stadnichenko)
Plate 24, figs. 5 *a-c*

Eponides texana STADNICHENKO, Journ. Pal., vol. 1, 1927, p. 232, pl. 38, figs. 1-5.

Shell calcareous, finely perforate, comparatively large, plano-convex or biconvex, composed of about three and a half coils; the dorsal side showing all the coils, those near the center covered by a smooth, transparent boss which partly hides the sutures of the first chambers, dorsal side flat in many specimens but convex in many others, ten to twelve chambers in the last whorl; ventral side with small raised boss and the last coil showing and having the secondary sutures developed giving a distinct star pattern so characteristic of this genus, ventral side usually papillose especially near the aperture which is covered by these decorations in almost all specimens. Length 0.68 mm.; width 0.60 mm.; thickness 0.33 mm.

Locality.—One mile north of Elkhart near railroad at Hopkins fault, Anderson County, Texas.

Range.—Mt. Selman greensand of Eocene.

U. S. National Museum Collection No. 371023.

CERATOBULIMINA EXIMIA (Rzehak)

Plate 24, figs. 3 *a-c*

Pulvinulina eximia RZEHAK, Ann. k. k. Nat. Hofmuseums, vol. 3, pt. 3, 1888, p. 263, pl. 11, figs. 7 *a-c*.

Ceratobulimina eximia TOULA, Jahrb. Geol. Reichsanst., vol. 64, 1920, p. 665.—CUSHMAN and HARRIS, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 4, 1927, p. 174, pl. 29, figs. 3, 4; pl. 30, figs. 12-16.—STADNICHENKO, Journ. Pal., vol. 1, 1927, p. 233, pl. 38, figs. 9-11.—COLE, Bull. Amer. Pal., vol. 14, no. 53, 1928, p. 220(20).

Rotalia dorri COLE, Bull. Amer. Pal., vol. 14, no. 51, 1927, p. 29, pl. 4, figs. 5, 6.

Test comparatively large, smooth, calcareous, finely perforate, biconvex, periphery rounded; eight to ten chambers in the last whorl; the sutures between chambers on the dorsal side having an angle about in the middle of these broad curves, all sutures depressed and definite on the ventral side but only the last three or four distinct on dorsal side. Only the last whorl with umbilicus exposed on the ventral side, while a large, smooth boss and one whorl are exposed on the dorsal side; aperture comma-shaped, in the last septal face. Length of specimen 0.60 mm.; width 0.46 mm.; thickness 0.34 mm.

Locality.—Three miles north of Bronson on Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—Cook's Mt. and Mt. Selman greensands of Eocene.

U. S. National Museum Collection No. 371015.

CIBICIDES SASSEI Cole

Plate 24, figs. 4 *a-c*

Cibicides sassei COLE, Bull. Amer. Pal., vol. 14, no. 51, 1927, p. 35, pl. 4, figs. 10, 11.

Test calcareous, coarsely perforate, plano-convex, dorsal side nearly flat, ventral side moderately convex; chambers numerous, eight to

EXPLANATION OF PLATE 24

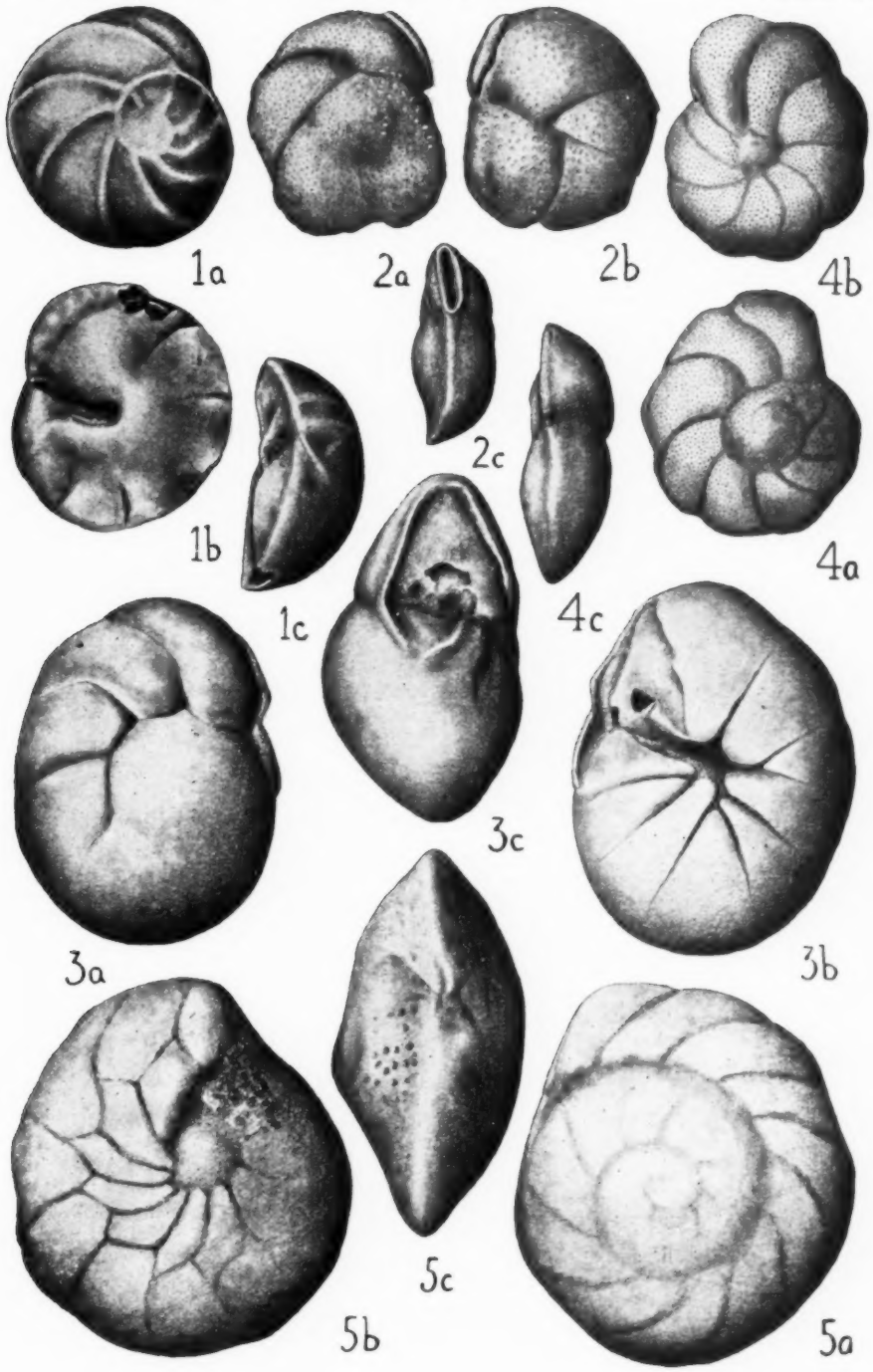
FIGS. 1 *a–c.*—*Lamarckina claibornensis* (Cushman). ×65, *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

2 *a–c.*—*Siphonina claibornensis* Cushman. ×75. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

3 *a–c.*—*Ceratobulimina eximia* (Rzehak). ×65. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

4 *a–c.*—*Cibicides sassei* Cole. ×65. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

5 *a–c.*—*Asterigerina texana* (Stadnichenko). ×65. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.


1a
2a
2b
4b
1b
2c
4a
1c
4c
3c
3a
3b
5c
5b
5a

ten in last whorl; peripheral margin lobate with edge slightly rounded; sutures slightly depressed and curving gently backward to margin; dorsal side showing a thin transparent boss and two and a half coils, the ventral side showing a smaller but more elevated and distinct boss and only the last coil, both right and left handed coiling noted; aperture slit at base of last chamber extending from dorsal side around periphery and on ventral side toward the boss. Length 0.43 mm.; width 0.35 mm.; thickness 0.15 mm.

Locality.—Three miles north of Bronson on Jasper—Tebo—San Augustine road, Sabine County, Texas.

Range.—Cook's Mt. greensand of Eocene.

U. S. National Museum Collection No. 371017.

Cole described this species from the Guayabal formation of Mexico.

A SIMPLE ACCESSORY STAGE FOR THE MICROSCOPE

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In micro-paleontological studies and in the examination of well cuttings, sands, and the like, it is often necessary to work over large quantities of finely divided rock material. In the sedimentation laboratory of the Illinois Geological Survey the apparatus shown in the accompanying illustrations and described herewith has been found very convenient for work of this type when used with the ordinary binocular microscope or even with the petrographic microscope.

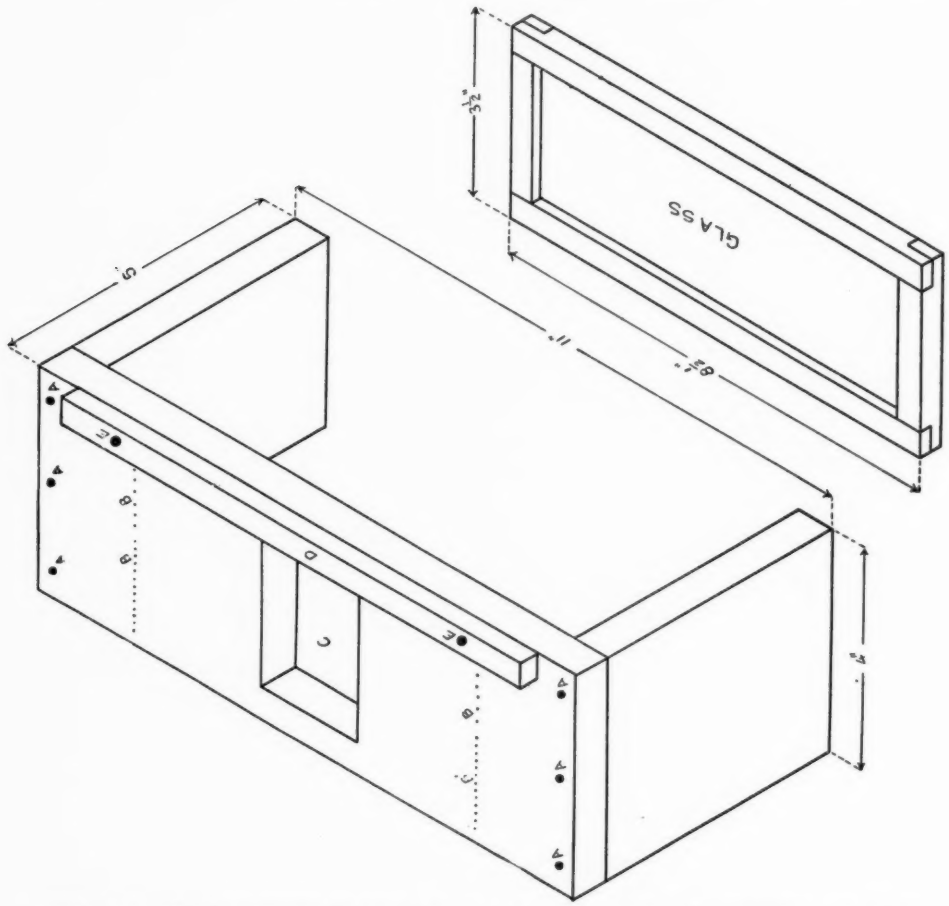
The apparatus consists of three principal parts, the stage shown in the upper part of figure 1, the guide marked D resting on the stage, and the tray shown below the stage. These three parts are described separately. They should be constructed of well seasoned, planed and sandpapered wood.

THE STAGE

Figure 1 is drawn to scale and the dimensions are given. The size of the apparatus is more or less optional, but it is generally desirable to make the uprights at either end of the stage only slightly higher than the stage of the microscope with which the accessory stage is to be used.

The nails A should be finishing nails and should be flush with or slightly countersunk below the top of the stage. The opening C (fig. 1) as well as its dimensions are optional; it is intended to permit the use of transmitted light. B and B′ are two parallel rows of holes about half an inch deep, driven as nearly vertical as possible, and just large enough to easily accommodate the nails EE in the guide D. Nails EE may be ¾-inch brads or cigar box nails.

Spaces between successive holes B should be the same size and should be slightly less than the width of the field of the microscope with the lowest power objective to be used. The spaces between the successive holes B′ should be equal and slightly less than the field of the microscope with the medium or high power objective. If more than two objectives are to be used additional rows of holes may be



made paralleling rows B and B′. The new rows will require another guide with the nails EE spaced to fit.

The Guide

Guide D is a bar of wood having two small nails or brads EE driven through it. Nails EE, if it is preferred, may be driven into the un-

derside of D so as to almost penetrate it and the heads of the nails clipped off and smoothed down; then D does not show the nailheads as in the figure. The distance between EE should be exactly equal to the distance between the rows of holes BB and B′B′.

The Tray

The tray is essentially a small picture frame and is constructed on the same general plan as a picture frame. The glass is held in place by brads in the back of the frame and by glue or shellac along that part of the frame with which the glass comes into contact. Sufficient glue or shellac should be used so that some of it squeezes out on the side of the glass shown in figure 1. This makes a tight contact between the glass and the frame and prevents fossils or other materials from lodging between the two. After the glue or shellac has hardened the surplus may be removed from the glass with a suitable solvent.

The size of the tray specified is convenient for use with the stage shown. A longer tray may be used with a longer stage than that shown in figure 1, but the width of the tray indicated is about the maximum that can be accommodated by the ordinary microscope.

If the apparatus is to be used for the examination of materials by both reflected and transmitted light it is advisable to make two trays. The under side of the glass in the tray to be used with reflected light is given a sufficient number of coats of black enamel to render it opaque; the glass in the tray for use with transmitted light is left clear.

Using The Accessory Stage

Assuming that the microscope is to be used with the low power objective to examine material by reflected light, the procedure is as follows:— the accessory stage is placed over the stage of the microscope with the holes B in the accessory stage toward the operator. (Fig. 2A.) Guide D is placed in the holes B closest to the operator. Some of the sample to be examined is then sprinkled on the enamel-backed tray; uneven distribution may be rectified by gently tapping the tray. The stage is swept with a small brush to make sure there are no grains of material on it, for this interferes with smooth movement of the tray. The tray is then placed on the stage against guide D, and the stage and tray moved bodily towards the operator until he sees the far edge of the tray through the microscope. The tray

is then moved from one side to the other against the guide and the position of the stage is modified so that when the tray is moved across the stage the field of the microscope covers a band which includes the far edge of the tray. The stage is then properly oriented and the examination of the cuttings can proceed. (Fig. 2A.)

The tray is held against the guide and slowly pushed from right to left while the observer makes the desired examination. When the right edge of the tray appears in the field the tray is pushed slightly

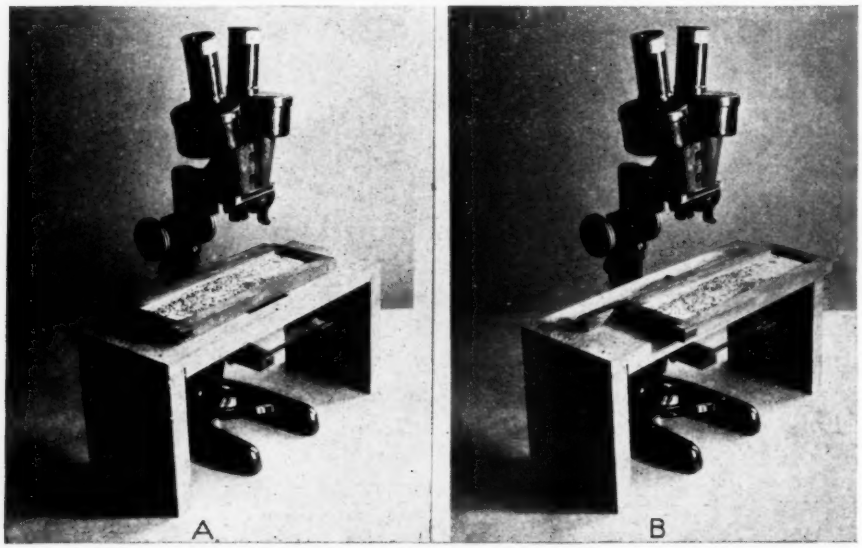


FIG. 2.—The accessory stage, tray, and guide in use. In A the stage is properly oriented and the tray and guide are in position to begin the examination of the contents of the tray. In B the tray and guide are shown at the completion of the examination.

forward and the guide moved forward into the next two holes BB. The tray is then brought against the guide and moved to the right. This process is repeated until the entire area of the tray has been covered. (Fig. 2B.) The tray may then be emptied and refilled and the operation repeated, except that the guide is now moved toward the operator instead of away from him.

The method of using the clear glass tray is the same. With higher power objectives the operation is also the same except that holes B′B′ are toward the operator.

PHOTOGRAPHIC SLIDE MOUNT FOR MICRO-FOSSILS

By HELEN JEANNE PLUMMER
Austin, Texas

Although the photographic slide mount has for many years been employed by European students of micro-fossils and of minute Recent shells and has been described by Mr. Frederick Chapman in the only comprehensive textbook on foraminifera[1], in this country it has not yet attained the popularity it well deserves. It is with the hope that her confrères in the field of micropaleontology may more fully appreciate the high degree of working efficiency that this type of slide mount offers, that she ventures to republish old data and to point out a few special uses to which the slide fitted with this feature can advantageously serve.

CONSTRUCTION OF SLIDE

Many new students in this branch of work are not familiar with the various slides employed. Perhaps it will therefore not be irrelevant to include in this paper brief directions for making the kind of slide that has proved highly satisfactory for plain mounts or for the special photographic mount to be discussed.

Probably most students in this field of endeavour use for mounting specimens the popular cardboard slide either with or without a protecting cover. The cardboard slide most commonly used consists merely of one strip of heavy white cardboard (25 mm. x 75 mm.) punched as desired and glued to a strip of black-faced cardboard of the same dimensions, a construction that produces a black background for specimens in a cell, the depth of which is the thickness

[1] Chapman, Frederick, The Foraminifera: Longmans Green, and Co., London, p. 310, fig. 41, 1902.

of the upper cardboard strip. Experience has shown that such a slide does not always endure climatic changes through a long period, and the parting of the two strips leads often to the loss of valuable material.

To make such a slide proof against conditions that cause deterioration, a strip of good bond paper (40 mm. x 75 mm.) is mounted to the upper surface of the upper cardboard (8- or 10-ply) strip and the desired hole cut or punched[2] through both materials (fig. 1a). A black cardboard strip of the same size is then glued in place beneath the hole in the upper strip, and the bond paper is brought tightly over the edges of the two strips and glued securely to the back of the slide (fig. 1b). Extra deep cells can be constructed by using more than a single thickness of cardboard in the upper part of the slide.

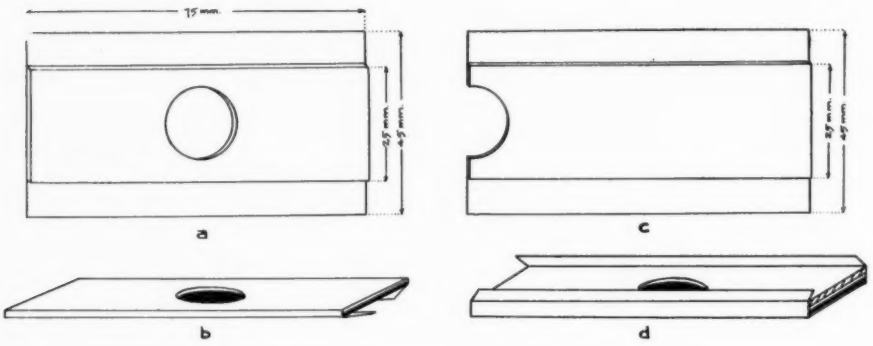


FIG. 1.—Diagram to show steps in construction of a covered slide.

This simple slide can be used and filed unprotected, or a cover glass can be cemented over the top of the cell.

For the best possible protection against damage to the mounted specimens and against accumulation of dust, the glass-topped sheath that fits tightly around the slide and yet slips off easily to permit direct access to the specimens in the cell is highly recommended. This feature requires a light-weight cardboard strip (25 mm. x 75 mm.) glued to the center of a piece of bond paper (40 mm. x 75 mm.) and punched at one or both ends to facilitate slipping the sheath from the slide (fig. 1c). The final step in the process consists in placing the cardboard slide on the cardboard strip of the sheath and a plain glass microscopic slide over the cardboard slide, and in cementing

[2] An excellent Krahn punch made to cut a 5/8-inch hole is distributed by Horder Stationery Stores, Chicago. A smaller punch that cuts a 3/8-inch hole can be obtained at any large office supply store.

firmly with good glue[3] the edges of the bond paper to the edges of the glass cover (fig. 1d).

Construction of Photographic Mounts

Designs for photographic mounts to be used in the cells of cardboard slides can be made to meet the requirements of almost any purpose or problem. The design or plat is first drafted on white paper with black ink in proportion, and of a size that will fit conveniently in the slide after having been reduced four times[4]. To procure a print of white lines on a black background, the drawing is then photostated and reduced to about one-half the original size. The final photographic process[5] then reduces the photostat copy to the precise size desired for use in the slide cell. For efficiency in printing slide mounts of which a large number is needed, it has been found advantageous to arrange several drafted plats of the same design for reproduction on a single film.

The construction of the slide bearing a photographic mount is precisely like that illustrated in figure 1 and described above, except that in place of the black cardboard strip, the photographic print is used as a mounting base in the cell. The photographic mount is first glued smoothly to a strip of cardboard (25 mm. x 75 mm.) in a convenient position, and in the upper thick cardboard strip a hole is cut to fit precisely over the slide mount.

Uses of Photographic Slide Mounts

The slide mount of design shown in figure 2 is very useful for many purposes. The author employs this mount for faunal assemblages at particular localities, for formational faunal groups from more than a single locality, for series of species in a single genus, and various other special purposes. It is very convenient to bring together for ready reference in this way species of published faunas[6], whenever type material can be procured. Plats can be made up for as small a series as is desired, but more than a hundred figured areas

[3] The author has tried several kinds of glue, but of these only Dennison's Glue has held high-grade bond paper securely and permanently to glass through all kinds of climatic conditions.

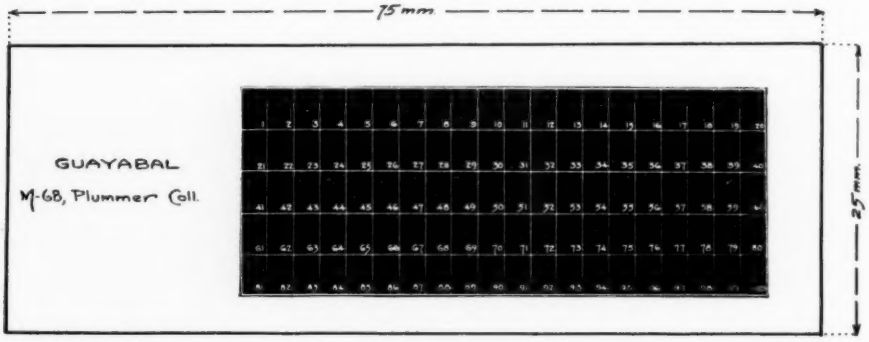
[4] The design shown in figure 2 was first drafted in a rectangle about 75 mm. x 185 mm. for final reduction to the desired size of approximately 19 mm. x 46 mm.

[5] Several who have tried making these slide mounts have experienced difficulties in producing a sharp negative that prints very clear designs on a deep black background through failure to employ proper methods and materials toward this end. It may be helpful, therefore, to point out the need of extended exposure of a Process film with the lens diaphragm greatly reduced, development of the film with a special hydrochinon developer (Eastman's green-label "Hydrochinon"), and printing on a contrast paper (F No. 3).

[6] For each such slide it is, of course, imperative to have a reference list of the numbered species either in a notebook or on cards.

crowds the maximum space that can be spared on the usual sized slide and still leave sufficient space at one end for a label. It has been found convenient to have mounts for series of 10, 25, 50, and 100. If a fauna of more than a hundred species is to be assembled on this plan, it is well to have mounts of 101-200, 201-300, and upwards as required, using a series of slides for the sequence. For large assemblages, it may be found more convenient to use a slide 50 mm. x 75 mm. for which size glass microscopic slides can be procured for the sheath.

It is customary in some commercial laboratories that are devoted mainly to the study and examination of well samples to assign a series of numbers to the species of each genus. For example, a certain laboratory may recognize twenty species of *Gyroidina* in the



2.—Top view of a slide equipped with a photographic mount of 100 numbered spaces.

stratigraphic section under observation by its workers. Each form then receives its own definite number instead of the usual type of specific name. For each such system it would be convenient to have each generic series arranged on a single slide mount marked off into numbered areas, instead of mounting each form on a separate slide. The grouping on a single slide affords also far better opportunity for comparison of closely similar forms, requires fewer slides and less labelling, and demands much less space in the filing system.

This same type of photographic mount illustrated in figure 2 has been highly desirable in university classes that are studying foraminifera and ostracods. One hundred different genera illustrated by specimens on a single slide can thus be conveniently studied from typical species mounted in order according to the classification used.

A series of three slide mounts bearing spaces numbered up to three hundred can present the entire range of any classification.

For very systematic study of the genera of foraminifera, it may be found preferable to arrange family groups on separate slides. For this purpose a plat of twenty-five numbered spaces is ample for any family group of the Cushman classification[7], or one of forty spaces for those of the Brady classification[8] together with its modifications and additions since 1884. In whatever text is chosen as a guide, the genera of each family can be numbered in series, and the correspondingly figured spaces on the slide mount for that family will carry specimens of typical species illustrating the genera. Family IX, Textulariidae, of Cushman's classification constitutes a group of 14 genera, which for convenience can be numbered in order of presentation in the text, thus constructing a handy index to the slides. Several months after this comprehensive classification was issued, Cushman and Waters[9] described the new genus *Spandelina*, which they assigned also to the family Textulariidae. This, therefore, becomes genus No. 15 of the group and can be recorded, with reference to the place of description, at the end of the text on this family and be illustrated by specimens in its respective position on the slide mount.

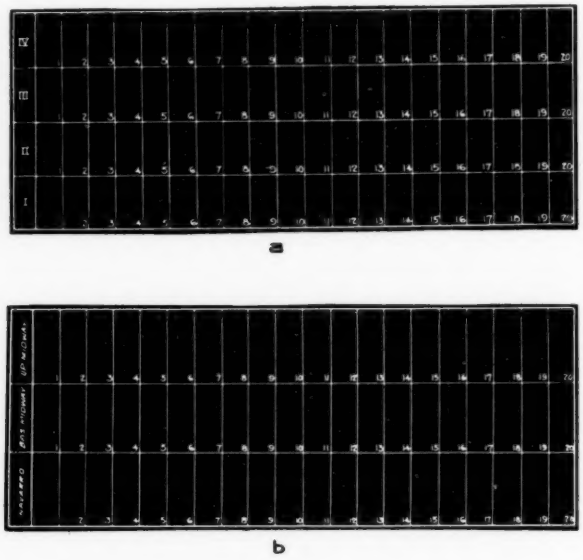
Carrying the application of this type of slide mount to a finer point, series of various species of generic groups can be similarly assembled. For thorough studies of genera, it is essential that each student construct such groups of species, since no genus can be adequately understood from a single specimen or from specimens of a single species. Though *Globorotalia tumida* (H. B. Brady) well illustrates the characteristic of the genus in which it stands, a comprehensive view of the generic group requires an acquaintance with a rather different form, *G. truncatulinoides* (d'Orbigny), which possesses also all the qualifications for its alliance with the genotype. Similarly *Valvulineria californica* Cushman and *V. allomorphinoides* (Reuss) are superficially quite different, but careful comparative studies show them to bear the same generic features. A mount that brings together generically related forms emphasizes the group characteristics and tends to abolish a mental picture of the genus based on a single representative species.

As a final refinement of this application of the slide mount of design shown in figure 2 to assemblages of forms, specimens of any

[7] Cushman, J. A., Foraminifera, their classification and economic use: Sharon, Mass., April, 1928.
[8] Brady, H. B., Report on the foraminifera dredged by H. M. S. Challenger during the years 1873-1876: Rep. Voy. *Challenger*, Zoology, vol. 9, pp. 60-77, 1884.
[9] Cushman, J. A., and Waters, James A., Upper Paleozoic foraminifera from Sutton County, Texas: Journ. Paleont., vol. 2, p. 363, December, 1928.

single species may be brought together from various formations and localities at which it occurs. The proximity in such groups is more likely to reveal recognizable varietal differences in form than can the usual method of mounting[10] specimens on separate slides.

Figure 3 presents two rather adaptable designs for short series of species in three or four stratigraphically successive formations. Series of species representative of diagnostic of each formation may be as-



3.—Two photographic slide mounts for use in comparison of series of species from successive stratigraphic units.

sembled for comparisons of faunas; or series of species of some single genus may be similarly grouped by formations to show clearly the character of development of the group of related forms through that part of the section represented by the design of the slide mount. In such plates either the formational names can be used in the design

[10] For mounting specimens a thick solution of gum tragacanth has been found far more satisfactory than any other kind of cementing material commonly used. To prepare it, soak a few lumps of the gum (obtainable at any good drug store) in about two cups of water for a day or two, at the end of which period they should be soft and clear. Set this thick solution over a very low flame and stir constantly while the temperature is brought up to the boiling point. Water should be added till the solution has the consistency of very heavy cream, and stirring should continue till all lumps have disappeared. After the solution has cooled, add several drops of oil of cloves to prevent souring during warm weather. To cement specimens to the slide, use a fine sable brush to apply the gum at the point on the slide where the specimen is to be mounted and set the specimen in the droplet. After drying, all traces of the cement will disappear, and if plenty of the gum solution has been used, adhesion is tight and permanent. To release such a specimen, only a damp brush is necessary to soften the cement. In mounting shells on the photographic slide mount, the combination of the gum and the emulsion of the photographic paper makes an especially strong cement.

(fig. 3b), or Roman numerals, to which formational names are assigned in the notebook record, can be used, thus making the mount useful for any series (fig. 3a). Such photographic prints can be trimmed down vertically, if only two formational groups of specimens are being compared; and they can be cut down laterally, if the series of specimens in the groups falls far short of the twenty spaces allowed.

The special purposes that the photographic slide mount serves can be extended indefinitely according to the character and factors of individual problems under investigation. The work of preparing especially designed mounts and constructing the slides is relatively small in comparison with the advantages offered by this plan of arrangement and study as to be almost negligible.

THE OSTRACODE GENUS HOLLINELLA, EXPANSION OF THE GENUS AND DESCRIPTION OF SOME CARBONIFEROUS SPECIES

By BETTY KELLETT
Cushman Laboratory, Sharon, Massachusetts

ABSTRACT

Evidence is presented pointing to the conclusion that members of the group recently set apart from the genus *Hollina* by Coryell under the generic designation of *Hollinella* are conspecific with certain frilled forms until now included under *Hollina*. The suggestion is made that these frilless Hollinids are simply the males and young of species, the mature females of which are typical frilled Hollinids. An interpretation of the narrow and wide frills of the females, hitherto considered of specific value, is suggested. Morphologic characters in a group of Hollinids of sufficient value to differentiate this group from the genus *Hollina* as typified by *Hollina insolens* (Ulrich) are pointed out, and Coryell's name, originally applied by him to forms whose characters are believed to be due to sexual dimorphism, is expanded to include the forms possessing these diagnostic characters. The genus *Hollinella* as emended includes Devonian to Permian forms.

A brief study of some upper Pennsylvanian and Permian Hollinellae (emend. Kellett) from Kansas is presented, and some species described by Harlton and Knight from various horizons are discussed and figured. Five new species are described and figured.

Hollinids are rare in the upper Pennsylvanian of Kansas between the Stanton limestone member of the Lansing formation and the Howard limestone of the Shawnee, but they become a conspicuous element in the ostracode faunas from the Howard up through the Winfield limestone of the Chase formation in the Permian. Collections from the Marion formation next above the Chase were confined to the Herrington limestone member and scarcely half a dozen ostracodes were found in material from as many localities.

It was noticed that the collections from each horizon contained very generally three sorts of Hollinids, one with a wide frill, one with a narrower frill and one in which the frill is represented merely by a linear row of spinelets or absent altogether.[1] These three sets of "species" as they were at first thought to be seemed to constitute three independent though closely related lines of descent. However, as the study progressed the changes in these three lines of descent seemed to follow each other too closely to be accounted for by parallel evolution; and the writer was forced to the conclusion that the members at any one horizon of what had appeared to be three separate lines are, when agreeing amongst themselves in all other characters except the frill, in fact conspecific and are examples of sexual di—or rather trimorphism.

The wide and the narrower frilled forms are represented in each of the Kansas species. They seem also to be shown in the figures of *Hollina herrickiana* Girty, figure 10 showing the wide frill, and figure 11 the narrower.[2] The frilless form has been identified in *Hollina emaciata* (Ulrich and Bassler) in *Hollinella nevensis*, Kellett, in *Hollinella gibbosa* Kellett, and in *Hollinella shawnensis* Kellett. Knight now believes that three of the forms described by him, *Hollina beuhleri* (plate 25, figure 5 *b* of this paper), *Hollina fortscottensis* (plate 25, figure 5 *c*), and the frilless *Hollina bassleri* (plate 25, figure 5 *a*), might be placed together as the three forms of *Hollina bassleri*, and has suggested the use of that name for all three of them.[3] Except for the frills and the smaller size of *Hollina bassleri* (in the original sense), they are all alike; the minor differences noted in the original descriptions such as prominence of nodes and granulations being found to be merely individual variations on examination of additional material collected by Knight from the type locality and loaned by him. In *H. bassleri* (as expanded) and in all of the species collected from Kansas, specimens which intergrade between the wide frilled form and the narrower are so rare as to suggest that the differences of the two forms are not to be attributed merely to individual variation. Plate 25 illustrates the three forms of the above named species. The frilless are in the left hand column, the narrow frilled in the center and the wide frilled at the right.

While it is quite impossible to demonstrate conclusively the relationships of the three forms to one another, the assumption that the frilless forms are the young of both sexes and the mature males,

[1] The forms without a frill were recently set apart by Coryell as a new genus under the name of *Hollinella*, Journ. Pal., v. 2, no. 4, 1928, p. 378.
[2] Girty, Bull. U. S. Geol. Surv., no. 389, 1909, p. 115, pl. 8, figs. 10-11.
[3] Personal communication.

while the frilled forms are the mature females, has much to lend it support. Furthermore, we may make a subdivision of the frilled forms into non-productive females with narrow frills and productive females with wide frills more or less concave on the inner side. Sexual dimorphism is almost characteristic in the Beyrichiidae of which Hollina (sensu latu) is a valid member and it is not surprising that something of the sort should be the case in this genus. I can only account for the relationship of the mature frilless form to the frilled, which relationship seems unmistakable for instance in a species with such distinct characteristics as *Hollinella nevensis*, plate 25, figures 2 *a-e*, by assuming that it is due to sex. Furthermore the scarcity of the mature frilless form is in accord with the fact often observed in many forms of animal life, namely, that the males are not as abundant as the females. The wide frilled form seems well adapted to be a productive female; because its frill does not follow closely the post-dorsal edge of the valve as does the narrower frill of the other form, but cuts obliquely across the angle a little way up on the valve. Thus the post-ventral portions of the frill on a closed carapace are set farther apart than those on the narrow frilled form. The space between them might provide, especially in those species with convex frills, a place "for the temporary lodgment and protection of broods of young".[4] The frequent moultings of ostracodes would allow for the changes in the female from the wide to the narrow frill. In *Hollinella digitata* Kellett, nom. nov. for *Hollina radiata* (Ulrich and Bassler) this difference in width and convexity of the frills was assigned to age[5], but of the several hundred specimens of that species and others, the wider frilled forms show no tendency to be larger or have thicker carapaces or be otherwise more developed than the narrower frilled forms. In none of them would it then seem that the differences in the frills were due to age.

Although some of the frilless forms are as large and mature as the frilled, the greater number found are clearly young specimens, because of their small size. No such small frilled forms were found, apparently showing that all the young are frilless.

The frilless forms *Hollinella* cf. *gibbosa*, plate 26, figures 2 *a-c*, show the intergradation in size and the development of the surface features in young to mature specimens. This development is typical of other species also. The anterior margins in side view of the smallest forms slant more obliquely backwards than those of the large forms, and the center of the valve slants sharply towards the mar-

[4] Ulrich and Bassler, American Silurian Formations, Maryland Geol. Surv., 1923, p. 275.
[5] Ulrich and Bassler, Proc. U. S. Nat. Mus., v. XXX, 1906, p. 156.

gins, instead of rounding out and making a fuller carapace as does that of the mature specimen. On the smallest specimens the surface beneath the sulcus is the highest point on the valve, and it extends smoothly along each side of the sulcus making a roughly U-shaped ridge at the dorsal ends of which the nodes develop as the carapace becomes larger. At first the anterior node is scarcely larger than the posterior, but with progressive age it increases much more rapidly in size than the posterior. Cardinal spines and partially developed marginal spines are found on even the smallest specimens, and the surface is sparcely sprinkled with coarse granules which later become thicker.

The Hollinids examined have a hinge structure consisting of a left valve with the interior of the hinge line grooved (as shown in plate 26, figures 6 and 7) to receive the tapered edge of the hinge line of the right valve along its greater length. This groove becomes less prominent at the center where the hinge-line narrows, and can be seen running entirely across it only on those specimens with a thickened dorsal edge. However, at the ends of the hinge line the right valve overlaps the left. On most species protuberances or spines mark the cardinal angles of the right valves and a small socket is hollowed out at the base of these cardinal angles inside the valve, into which sockets fit the corners of the left valve. This overlap of the right valve over the extremities of the left is most pronounced at the anterior end. Plate 26, figure 5, shows the interior of a right valve with a white matrix which extends up into the sockets at the cardinal angles.

The margins of the valves show the structure described by Knight[6] consisting of a beveling of the outside of the margin of the left valve and the inside of the right valve, resulting in a slight overlap of the right valve over the left. In some species this beveling on the left valve is bordered by a row of minute beads. These beads are especially well developed on *Hollina radlerae* Harlton, plate 26, figure 6.

In the early stages of the work it was thought possible that the hinge and marginal structures observed in the Carboniferous Hollinae might serve to differentiate them from the older Hollinae for which no such structure had been described, and especially from the type of the genus, *H. insolens* (Ulrich). A brief study of the material in the U. S. National Museum, served to demonstrate that while Hollinae with the beginnings of hinge structure and well developed marginal characters do indeed extend back into the Devonian, *Hollina*

[6] Knight Journ. Pal., v. 2, no. 2, June 1928, p. 229.

insolens (Ulrich) is not one of them. The types of *Hollina antispinosa* (Ulrich) from the Hamilton show clearly the cardinal spines and the beveling of the ventral margins, and indicate the hinge grooving in the left valve and the cardinal pits on the right valve. But in *Hollina insolens* (Ulrich), not only is the noding and form of the frill of somewhat different character, but neither is any hinge or marginal structure shown. Instead, the margins of the holotype, upon which these observations are based, were thickened and smooth. The type appeared to be well preserved. Thus while we cannot draw a line between the Carboniferous and the older Hollinae, we have *H. antispinosa,* which also resembles the Carboniferous forms in frill and noding to a great extent, and the Carboniferous Hollinas differing from the genotype in such a fundamental and distinctive character as to warrant their being separated from the genus *Hollina.*

Their proper position seems to be in the genus *Hollinella* Coryell. For as this genus was established the members are entirely typical of the Carboniferous specimens heretofore referred to as Hollinae, having the same marginal and hinge structure, and the same general nodation, differing only in the lack of a frill. Since it is fairly evident that the presence or absence of the frill is not necessarily of even specific importance, it seems that all of the Carboniferous Hollinae and *Hollina antispinosa* (Ulrich) should be placed in the genus Hollinella as revised to include all forms with the above described marginal and hinge structure, whether frilled or frilless. Upon examination of the margins other pre-carboniferous species may be placed in this genus. If it is later advisable, after the publication of more Carboniferous Hollinellae, to divide the genus into two or more genera on the basis of nodation or of frill characters, then the important relationship of these genera as shown by the marginal and the hinge structure should be indicated by placing them together in a sub-family.

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Genus HOLLINELLA Coryell, 1928, emend. Kellett

HOLLINELLA NEVENSIS Kellett, n. sp.
Plate 25, figs. 2 *a-c*; plate 26, fig 4

FEMALE

Carapace presenting a rectangular appearance, although slightly subrhomboidal; ventral margin approximately paralleling the straight hinge line; length twice the width or less. Anterior margin only very slightly rounded and protuding. Upper half of the posterior margin oblique, and on the narrow frilled form rounding into the ventral margin. The wide frill makes an obtuse angle at the center back of the valve where it suddenly narrows. Hinge and marginal structure that of the genus. Beading along left margin lacking. Valve fairly convex with the surface features having an inflated appearance. A broad fairly deep sulcus located behind the center of the valve. Anterior node with a diameter about half the height of the carapace, hemispherical, placed almost up to the hinge line, and broadly and evenly confluent with the ridge beneath the sulcus. This ridge in turn blends smoothly into the tumid posterior of the valve and the posterior node, but is raised somewhat above the general convexity of the ventral portion. The posterior node is small, and inconspicuous, and raised only slightly above the posterior of the valve. Narrow frill on non-productive female, plate 25, figure 2 *b*, of constant width ventrally and parallel and close to the border of the valve at the postero-dorsal angle; on productive female, plate 25, figure 2 *c*, of moderate width and slightly plicated, not convex, and ending anteriorly in a spine at the outer edge of the frill. It has a pronounced upward plication at the postero-ventral angle, and extends from the center of the posterior margin to posterior cardinal angle as a slight rim composed partly of small tubercles. An irregular row of papillae on the anterior edge and a few short inconspicuous ones may be developed behind them and on the anterior node. Cardinal spines on the right valve prominent. Surface irregularly punctate.

MALE

Like the female except that it lacks the frill and carries instead of a row of faint to distinct spines closely placed, plate 25, figure 2 *a*. Mature specimens are sometimes as large as the frilled form, but there is an intergradation in size not found in the frilled *H. nevensis* to specimens one-half the length of the adult. The smallest one resem-

bles Jonesinas because the nodes are undeveloped although the sulci are distinct. This graduation in size is common to all of the frilless forms in my collection and has also been noticed by Harlton to occur in the frilless *Hollinella grahamensis* (Harlton) and *Hollinella oklahomaensis* (Harlton).[7]

	Productive female	Nonproductive female	Male
Length	1.12 mm.	1.12 mm.	.97 mm.
Height	.73 mm.	.66 mm.	.60 mm.
Thickness		57 mm.	

H. nevensis was found only in the Neva, and as it was found in widely separated localities it may be a good index fossil. It is easily distinguished by the broad confluence of the anterior node and the ventral ridge.

Horizon and localities: Neva, 42 abundant; 60, rare. Holotype U. S. Nat. Mus., No. 80518.

HOLLINELLA EMACIATA (Ulrich and Bassler)

Plate 25, figs. 1 *a-c*

Beyrichia? emaciata (ULRICH and BASSLER), Proc. U. S. Nat. Mus. no. 1446, v. XXX, 1906, p. 156, pl. 11, fig. 6.

FEMALE

General outline of the carapace from the side the same as *H. nevensis*, but much less tumid; marginal structure, frill and cardinal spines also the same. However, the two forms present an exceedingly different appearance; for whereas the valve of *H. emaciata* is only slightly convex with a great deal of relief above and below the general surface, that of *H. nevensis* appears inflated and smooth. A deep, narrow, sulcus with a wide, almost straight ventral end extends at least half way to the frill, and anteriorly is bordered by a large regularly rounded node. On specimens from the Cottonwood Falls limestone at Ogden, this node is generally broader and more bulbous, extending from the hinge line half way down the valve. The node behind the sulcus is low and vertically elongate, making only a slight angle posteriorly with the rather flat surface of the valve. The posterior node is a little farther from the hinge line than the anterior. The ventral side of the narrow, almost straight ridge beneath the sulcus descends so sharply toward the frill that it appears

[7] Personal communication.

to be pinched into shape. The ventral ridge converges smoothly with the posterior of the valve, but is cut off from the anterior node above it by a distinct sulcus. It is often as much elevated as the anterior node. Bassler[8] has decided that the "short, vertical, curved ridge in the postero-dorsal angle" of the original description is merely a deformation of the type specimen. Surface of the valve irregularly punctate, but rougher than *H. nevensis*, with granulation on the frill, the sulcus and along the margins. This likeness of surface texture, rectangular side view and broad anterior nodes makes it seem possible that *H. nevensis* is the ancestor of *H. emaciata*.

H. emaciata is characterized by a generally emaciated appearance, by a long sulcus with a broad lower end, by a straight, narrow, ventral ridge, and by a prominent node cut off entirely from the ventral ridge by a narrow sulcus.

MALE

Like the female, except that it lacks the frill; anterior node in the specimens observed are slightly less bulbous also. Marginal spines of medium size, closely placed; however, as they are broken, their length cannot be determined. Only two undoubted specimens have been found—one in the Cottonwood Falls limestone, locality 44, and the other in the Fort Riley, locality 45, plate 25, figure 1 *a*. A similar undescribed form has been found in the Winfield which has long club-shaped spines. The males of *H. emaciata* and *H. nevensis* differ from all other previously described frilless forms in their nearly rectangular outline from the side. They differ from each other in the same respects as do the females of the species.

	Productive females	Nonproductive females	Male
Length	1.21 mm.	1.09 mm.	1.00 mm.
Height	.69 mm.	.69 mm.	.62 mm.

In my collection *H. emaciata* occurs lowest in the column in the Cottonwood Falls limestone, at locality 44. It is found farther up, in the Wreford limestone, locality 43; and the Fort Riley, locality 45. A doubtful form occurs in the Winfield; it has thickened edges and not such an "emaciate" appearance.

Plesiotypes, U. S. Nat. Mus., No. 80519, 80519 *a*.

[8] Personal communication.

EXPLANATION OF PLATE 25

All figures X 30

All specimens in left hand column are the frilless form of the species, in the center the narrow-frilled form, and on the right the wide-frilled

FIGS. 1 *a–c.—Hollinella emaciata* (Ulrich and Bassler).

a Left valve frilless form, plesiotype, U. S. Nat. Mus., No. 80519 *a*, Fort Riley limestone, locality 45.

b Left valve narrow frilled form, plesiotype, U. S. Nat. Mus., No. 80519, Wreford limestone, locality 43.

c Right valve wide frilled form, plesiotype, U. S. Nat. Mus., No. 80519, Wreford limestone, locality 43.

2 *a–c.—Hollinella nevensis* Kellett, n. sp.

a Right valve frilless form, paratype, U. S. Nat Mus., No. 80518 a, Neva limestone, locality 42.

b Right valve narrow-frilled form, paratype, U. S. Nat. Mus., No. 80518 *a*, Neva limestone, locality 42.

c Right valve wide-frilled form, holotype, U. S. Nat. Mus., No. 80518, Neva limestone, locality 42.

3 *a.—Hollinella* cf. *gibbosa* Kellett, n. sp.
Right valve frilless form, U. S. Nat. Mus., No. 80513, Cottonwood Falls limestone, locality 59.

3 *b–c.—Hollinella gibbosa* Kellett, n. sp.

b Right valve narrow-frilled form, paratype, U. S. Nat. Mus., No. 80515, Fort Riley limestone, locality 45.

c Right valve wide-frilled form, holotype, U. S. Nat. Mus., No. 80511, Emporia? limestone, locality 40. Specimen exfoliated.

4 *a–c.—Hollinella shawnensis* Kellett, n. sp.

a Right valve frilless form, paratype, U. S. Nat. Mus., No. 80510 *a*, Howard limestone, locality 25. Spines broken at center of ventral margin.

b Left valve narrow-frilled form, paratype, U. S. Nat Mus., No. 80510 *a*, Howard limestone, locality 25. Outer granular layer exfoliated except ventrally.

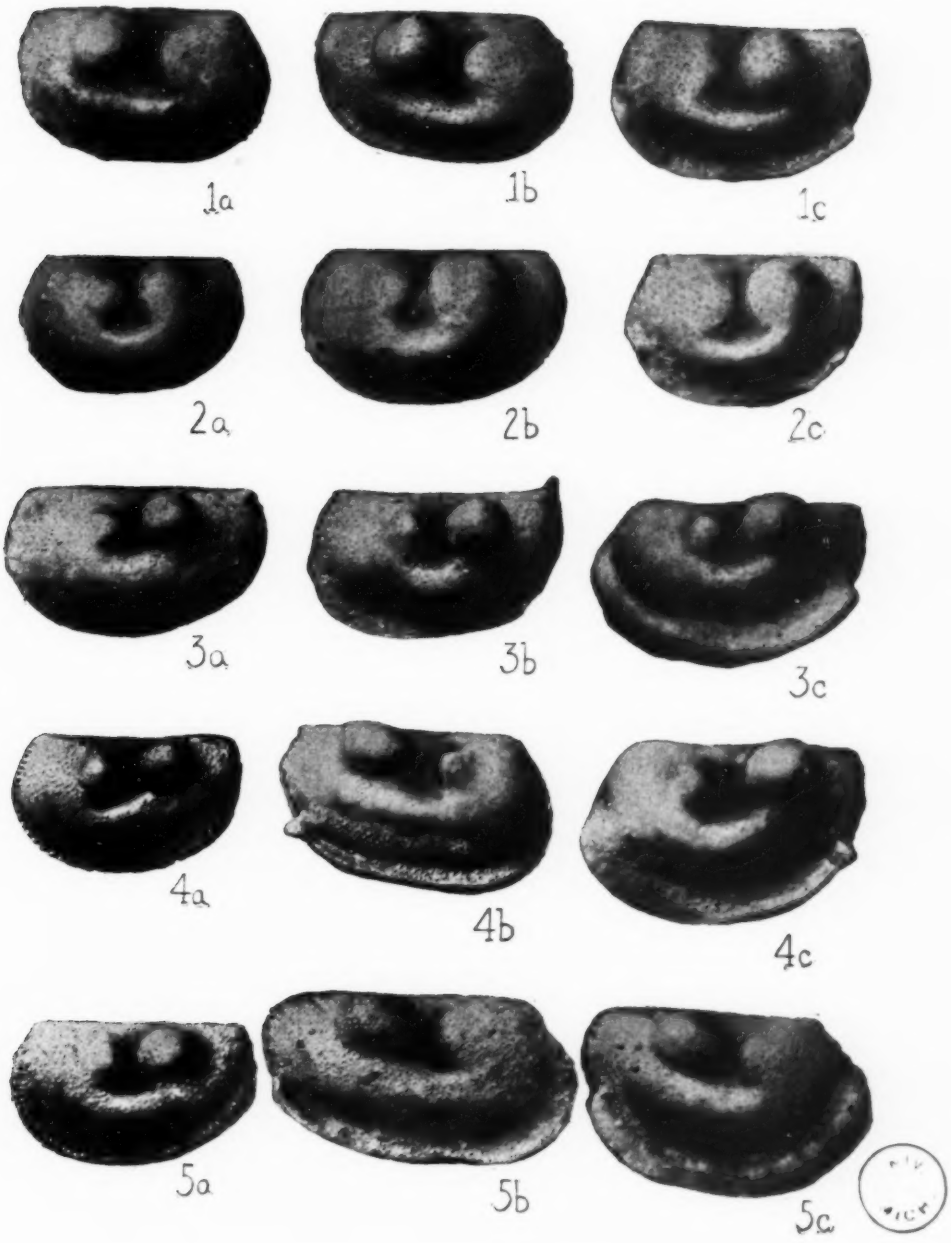
c Right valve wide-frilled form, holotype, U. S. Nat. Mus., No. 80510, Howard limestone, locality 25.

5 *a–c.—Hollinella bassleri* (Knight), plesiotypes, U. S. Nat. Mus., No. 80522.

a Right valve frilless form, Upper Fort Scott limestone, Knight's locality 38, St. Louis County, Missouri.

b Left valve narrow-frilled form, same locality.

c Left valve wide frilled form, same locality.


1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
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5b
5c

HOLLINELLA CRASSAMARGINATA Kellett, n. sp.
Plate 26, figs. 3 *a-b*, 7

FEMALE

Carapace rhomboidal to sub-rectangular. Anterior margin only slightly rounded and protruding, sometimes however having a backward swing. Posterior margin slightly rounded to extremely so, with the greatest protuberance below the center of the valve making the posterior appear obliquely truncate. Dorsal and ventral margins only slightly rounded and nearly parallel. Hinge and marginal structure that of the genus. Marginal beads on left valve lacking.

Sulcus behind center of hinge line, not deep and often short. Anterior node hemispherical, touching the hinge line, and smaller than that of *H. emaciata.* Posterior node not much elevated above the posterior surface of the valve. Ridge beneath sulcus not prominent and gently rounding down to frill. Valve with frill presenting a rather flat appearance with only the anterior node standing out prominently. Frill thickened, fairly broad posteriorly making a prominent rim at the posterior of the valve which may extend slightly on to the dorsal margin. Frill at the postero-ventral angle flat and paralleling the plane of juncture of the valves, but anteriorly set on at an angle and ending in a short flat spine. Frill of medium width on non-productive female, plate 26, figure 3 *b;* wide on productive female, plate 26, 3 *a.* Frills set on carapace so that when it is closed they are well apart, not close together as on *H. emaciata* and *Hollinella gibbosa* Kellett, n. sp. Anterior of valve bordered irregularly by a row of papillae. A few small papillae, sometimes arranged in a row running diagonally downward and backward, in front of the anterior node, and often on the anterior node itself. This arrangement of very sparce, inconspicuous papillae is common to almost all of the Hollinellae from Kansas; only on the specimens of *H. shawnensis* Kellett is the diagonal row missing. Surface slightly granular.

H. crassamarginata is small below the Neva, but in the Neva and above, it occurs in a distinctly larger size, the two sizes occurring together sometimes. In my collection those in the Cottonwood Falls are small. The small forms have a few rather shortened specimens.

H. crassamarginata differs from *H. emaciata* in the following characters; anterior node smaller and flatter; sulcus shorter and shallower; marginal frill thicker and flatter, the thickening making a prominent rim posteriorly up to the hinge; general appearance flat rather than emaciate. It is distinguished from *H. gibbosa* by the pronounced posterior rim, by the less prominent node, and by the

thicker, flatter and narrower frill which is never convex as is the frill of the productive female of *H. gibbosa*.

Male

Because *H. crassamarginata* and *H. gibbosa* are differentiated chiefly by their frills I have not been able to separate and identify the male forms of each, although perhaps those which are a little higher on the ones having the coarser, bead-like spines are the males of *H. crassamarginata*.

	Large type female	Small type female
Length	1.09 mm.	.66 mm.
Height	.94 mm.	.57 mm.

Horizons and localities. Stanton, 21, rare; Ervine Creek limestone, 18, rare; Howard, 25, rare; Americus, 70; Neva, 63, 64, 65; Cottonwood Falls, 67, abundant; Wreford, 43; Fort Riley, 45. Holotype, U. S. Nat. Mus., No. 80521.

HOLLINELLA GIBBOSA Kellett, n. sp.
Plate 25, figs. 3 *a*? 3 *b-c*; Plate 26, figs. 5, 14

Female

Carapace semi-ovate to rhomboidal, length about twice the height, anterior end slightly rounded, posterior obliquely truncate dorsally and rounding below into the ventral margin. Marginal and hinge structure typical of the genus. An even row of minute beads bordering the beveling on the left valve. Cardinal spines on right valve prominent. Sulcus behind center of hinge line rather short and wide. Anterior node set up above the general surface of the valve, bulbous and somewhat constricted at the base. Posterior node of a small diameter but often well raised above the posterior surface of the valve—somewhat inflated. Ridge beneath the sulcus having a slight to a prominent curve, and sometimes quite gibbous, especially on those forms occurring near the top of the Pennsylvanian. Generally convexity of the valve not great. Frill on non-productive female, plate 25, figure 3 *b*, fairly wide and beginning with an elevated spine which rises about three-fourths of the way down the anterior margin at a little distance from the edge of the valve; the frill continuing downward and backward so that at the postero-ventral angle it follows the edge of the valve closely. On a closed carapace the frills diverge anteriorly but become almost parallel at the postero-ventral angle. The wider frill of the productive female, plate 25, figure 3 *c*,

is posteriorly set up on the valve at a little distance from the margin, and is very convex. A depression occurs along the junction of the frill with the valve. On both female forms the frill widens at the postero-ventral angle and then narrows suddenly, dying out before it reaches the hinge line.

Anterior margin bordered by a few short irregular spines. Surface finely granular, granules extending up on frill. A few very short papillae on anterior node and in front of it, sometimes arranged in a diagonal line running backward.

H. gibbosa is very closely related to *H. bassleri* Knight, as the species is above enlarged, but *H. bassleri* is more tumid and slopes more toward the dorsal and ventral margins, with the anterior node on the ventral slope instead of being nearly level as is that of *H. gibbosa*. The nodes, especially the posterior, are less globular and restricted at the base than those of *H. gibbosa*. The frill of *H. bassleri* is of more even width and is wider posteriorly, extends farther up toward the hinge both anteriorly and posteriorly, is more elevated especially at the postero-ventral angle, and is less convex on the productive female.

MALE

As stated above the males of *H. crassamarginata* and *H. gibbosa* have not been separated, but it is likely that the forms figured, plate 25, figure 3 *a;* and plate 26, figures 2 *a-c* are the male and the young of the latter species. Figure 3 *a* is much like the male of *H. bassleri* (plate 25, figure 5 *a*) but the nodes are more inflated than on the latter; the females of *H. gibbosa* and *H. bassleri* differing in this same respect. Both the forms just referred to, figure 3 *a* and the male of *H. bassleri,* resemble *Hollinella harltoni* Kellett, n. sp. (plate 26, figures 10 *a-b*) in side view, but in a dorsal view the forms first discussed are diamond shaped, tapering at each end, while the sides of *H. harltoni* (figure 10 *b*), are more nearly parallel. Furthermore the nodes protrude out from the general curvature of the valves more than on *H. harltoni.*

	Productive female		Nonproductive female	Male
	large	medium		
Length	1.36 mm.	1.24 mm.	1.18 mm.	1.12 mm.
Height	.89 mm.	.72 mm.	.63 mm.	.63 mm.

Horizons and localities: Burlingame, 15, 71; Americus, 70; Neva, 60, 64, 65; Cottonwood Falls, 58, 66, 67; Fort Riley, 45. Holotype, U. S. Nat. Mus., No. 80511.

HOLLINELLA SHAWNENSIS Kellett, n. sp.
Plate 25, figs. 4 *a-c*; Plate 26, fig. 8

FEMALE

H. shawnensis is chiefly differentiated from the related *H. gibbosa* by the character of the juncture of the frill on the productive female, plate 25, figure 4 *c* to the valve at the post-ventral angle. Instead of the ventral depression continuing around to the posterior as in *H. gibbosa*, the frill and the valve are smoothly confluent at the post-ventral angle, one rounding into the other where the valve is most convex posteriorly. The valve is also shorter than that of *H. gibbosa*, and the anterior node has a larger diameter. The top of the anterior node slants toward the sulcus and the hinge line, a feature more characteristic of *H. bassleri* than of *H. gibbosa*. *H. shawnensis* is probably intermediate between these species. The specimens of *H. shawnensis* examined lack the diagonal row of incipient spines present on the anterior of the other Hollinellae from Kansas.

MALE

Mature specimens fairly numerous and showing the backward slope at the top of the anterior node noticeable on the female of the species. The males resemble those of *H. bassleri* very much but differ from the latter in the inner row of spines being coarser and more widely spaced and in the nodes being more prominent. The nodes protrude more from the general convexity than on *H. harltoni*, and the carapace is thicker.

	Productive female	Male
Length	1.18 mm.	1.00 mm.
Height	.72 mm.	.58 mm.

Horizons and localities: Ervine Creek division, Deer Creek limestone, 18, rare; and Howard limestone, 25, abundant; both members of the Shawnee formation. Holotype, U. S. Nat. Mus., No. 80510.

HOLLINELLA DIGITATA Kellett, nom. nov.
Plate 26, figs. 1 *a-b*

Beyrichia radiata (ULRICH and BASSLER, non JONES and KIRKBY), Proc. U. S. Nat. Mus. No. 1446, v. XXX, 1906, p. 156, pl. XI, fig. 5.

Only females have been found. A number of well preserved specimens of *H. digitata* were found about four miles from the locality of

those described by Ulrich and Bassler. Complete specimens bear a medium to long, thick spine terminating the anterior of the frill and extending obliquely to perpendicularly away from the valve. In one specimen this spine is so much developed as to be sickle shaped and about one-half the length of the valve. *H. digitata* has also the marginal structure described in the above Hollinellas. The cardinal spines on the right valve are extremely well developed, the anterior one usually the larger, with the hinge line not altogether straight but sloping slightly up in front of the anterior node to the cardinal spine. The difference in the convexity of the frills noted in the original description would seem, after studying the other Kansas Hollinas, to be due to sex rather than to age. The frill of the nonproductive female, plate 26, figure 1 *b*, is wide, and at the postdorsal angle flat and arising close to the edge of the valve, but it is not convex; while that of the productive female, plate 26, figure 1 *a*, is extremely convex posteriorly and cuts obliquely across the postventral angle.

Length	1.12 mm.
Height	.60 mm.

H. digitata is closely related to *H. gibbosa*, but it has the additional ornamental features:—the finger like papillae, and the more strongly developed cardinal spines and spine at the end of the frill. Knight described a species somewhat similar to *H. digitata* from the Henrietta of Missouri which he named *Hollina ulrichi*, and which he considered to be the same as *H. radiata* (Ulrich and Bassler, non Jones and Kirkby). However, after examining the plesiotype described by Ulrich and Bassler, it seems that the specimens collected by the writer close to the original locality and horizon belong to the same species as *H. radiata* (Ulrich and Bassler), but the Kansas specimens differ from *H. ulrichi* Knight, in that the papillae are never crowded together as on the types of *H. ulrichi*, and also the nodes are more bulbous. However, the writer agrees with Knight that the name used by Jones and Kirkby cannot be applied with any assurance to the American forms; if for no other reason than because it is impossible to tell to which of the several rather distinct forms figured by Jones and Kirkby it belongs.

H. digitata has been found only in the Cottonwood Falls and Wreford members, but specimens are found sixty-five miles apart at practically the same horizons.

Horizons and localities: Cottonwood Falls limestone, 44; Garrison shales, 68a; Wreford limestone, 43. First found by Ulrich and

Bassler in the Cottonwood shales, 2 miles east of Cottonwood Falls, Kansas. Holotype, U. S. Nat. Mus., No. 80517.

The following frilless specimens from Oklahoma are figured at the suggestion of Mr. Bruce H. Harlton, who kindly loaned the specimens. It seemed advisable to figure and contrast these very similar frilless forms from Oklahoma, no two of which have been figured together, the frilless *H. bassleri* Knight, and the four male Hollinellae from Kansas. The writer regards the Oklahoma frilless species as male forms. The corresponding females of some of these have been tentatively identified with published figures of Hollinae, but the writer feels that it is unsafe to make such identifications without the study of the whole fauna, as was done in the Kansas material.

HOLLINELLA HARLTONI Kellett, n. sp.
Plate 26, figs. 10 *a-b*

Male form only has been recognized. Carapace sub-elliptical in side view, and narrow oval with rather pointed ends in dorsal view. Hinge lines straight, with slight protuberances at the cardinal angles of the right valve. In side view the anterior margin is almost straight, slanting only slightly anteriorly until it reaches a point at about half the height of the valve when it swings backward and downward toward the posterior half of the valve where the margin rounds evenly up to the hinge line. Only a closed carapace has been observed, but from the nature of the overlapping cardinal angles of the right valve it is safe to assume that the rest of the hinge and the marginal structure is the same as that described for the other species in this

EXPLANATION OF PLATE 26

All figures X 30

FIGS. 1 *a–b.*—*Hollinella digitata* Kellett, nom. nov. for *Hollina radiata* (Ulrich and Bassler) (non Jones and Kirkby).

a Right valve wide-frilled form, holotype, U. S. Nat. Mus., No. 80517, top Garrison shale, locality 68a.

b Left valve narrow-frilled form, paratype, U. S. Nat. Mus., No. 80517 *a*, top Garrison shale, locality 68a.

2 *a–c.*—*Hollinella* cf. *gibbosa* Kellett.
Series of right valves illustrating the development with age, note especially the enlarging of the anterior node. U. S. Nat. Mus., No. 80514, Neva limestone, locality 64.

3 *a–b.*—*Hollinella crassamarginata* Kellett, n. sp.
a Right valve wide-frilled form, holotype, U. S. Nat. Mus., No. 80521, Cottonwood Falls formation, locality 67.
b Right valve narrow-frilled form, paratype, U. S. Nat. Mus., No. 80523, Fort Riley limestone, locality 45.

4.—*Hollinella nevensis* Kellett, n. sp.
Dorsal view carapace, paratype, valves slightly spread apart by filling. U. S. Nat. Mus., No. 80518 *b*, locality 42.

5.—*Hollinella gibbosa* Kellett, n. sp.
Interior right valve showing sockets at cardinal angles. Specimen filled with a white matrix which extends up into sockets. Holotype, U. S. Nat. Mus., No. 80516, locality 59.

6.—*Hollinella radlerae* (Harlton), n. comb.
Interior left valve showing grooved hinge of left valve. This is a trinodate species. Belle City limestone, Pontotoc County, Oklahoma.

7.—*Hollinella crassamarginata* Kellett, n. sp.
Interior left valve showing grooved hinge on left valve in this binodate species, paratype, U. S. Nat. Mus., No. 80523, Fort Riley limestone, locality 45.

8.—*Hollinella shawnensis* Kellett, n. sp.
Dorsal view wide-frilled form, paratype, U. S. Nat. Mus., No. 80510 *b*, Howard limestone, locality 25. Most of surface exfoliated.

9 *a–b.*—*Hollinella menardensis* Harlton.
a Left side carapace, Menard County, Texas.
b Dorsal view same. Specimen badly weathered, surface roughened.

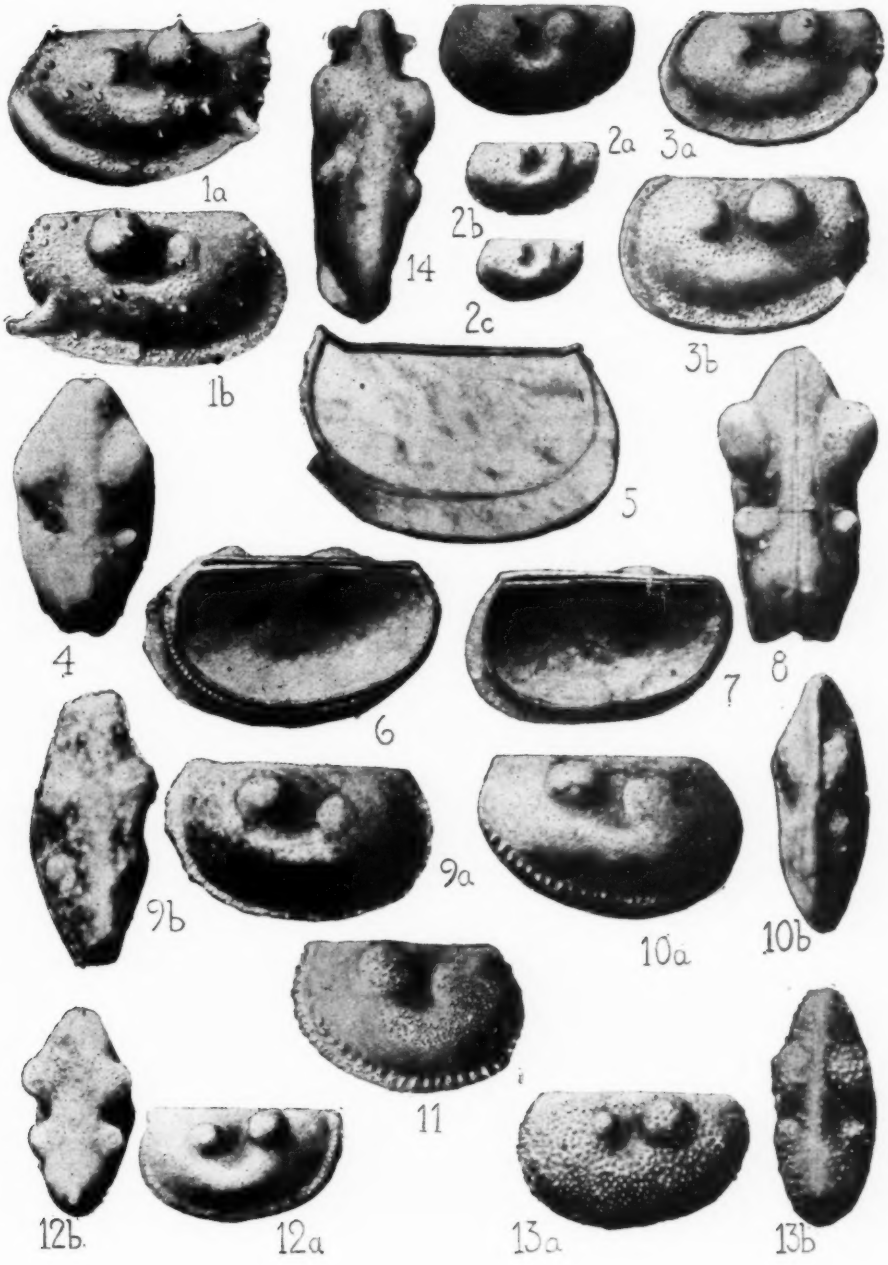
10 *a–b*—*Hollinella harltoni* Kellett, n. sp.
a Left valve, holotype, U. S. Nat. Mus., No. 80524, Belle City limestone, Pontotoc County, Oklahoma. Line on anterior node is a crack.
b Dorsal view same. The ridge-like appearance of the hinge line is caused by compression at the hinge, although the specimen as a whole does not seem to be deformed.

11.—*Hollinella grahamensis* (Harlton).
Left valve holotype (after Harlton), U. S. Nat. Mus., No. 71413, Upper Glen, Love County, Oklahoma.

12 *a–b*—*Hollinella* cf. *menardensis* Harlton.
a Right side, U. S. Nat. Mus., No. 80525, Menard County, Texas.
b Dorsal view same specimen.

13 *a–b.*—*Hollinella oklahomaensis* (Harlton).
a Belle City limestone, Pontotoc County, Oklahoma.
b Dorsal view same specimen.

14.—*Hollinella gibbosa* Kellett, n. sp.
Dorsal view wide-frilled form, paratype, U. S. Nat. Mus., No. 80512, Cottonwood Falls limestone, locality 67.



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paper. Sulcus shallow and converging gently with the smoothly rounding surface beneath it. The base of the sulcus slants obliquely toward the posterior. Anterior node circular, very low, with a diameter about one-third the height of the carapace. Posterior node not raised above the ventral and posterior surface of the valve. A row of stout spines, evenly and widely spaced, runs parallel to the ventral margin. A second inconspicuous row of small, sparce, unevenly placed spines extends inside this row at the ventral margin. These two rows of spines merge and die out at each end about half way up the carapace, rather suddenly at the anterior and where the inner row is most prominent. Surface granules not large.

	Male
Length	1.15 mm.
Height	.35 mm.
Thickness	.20 mm.

This specimen resembles the male of *H. bassleri* (Knight) (plate 25, figure 5 *a*) very much, but the spines are not fine and closely spaced as those of *H. bassleri* and they do not continue so far up the anterior and posterior margins. In dorsal view the sides of *H. harltoni* are more nearly parallel and the nodes do not protrude so much as on *H. bassleri.* In shape *H. harltoni* is very near *H. oklahomaensis* (Harlton), (plate 26, figure 13 *a*); but these two forms are readily distinguishable because the granulations on *H. oklahomaensis* are so large as to resemble small spines under the highest power it lacks the marginal rows of spines. The marginal rows of spines on the male *H. shawnensis* (plate 25, figure 4 *a*) are similar; but these species differ in the amount of protuberance of the nodes, as can be seen by comparing figures 8 and 10 *b*, plate 26. *H. harltoni* differs, as do all the other forms described in this paper, from *Hollinella dentata* Coryell,[9] in the position of the greatest length of the valve. In *H. dentata* this is at the hinge line and in *H. harltoni* it is in the dorsal half well toward the center of the valve.

This species is named after Mr. Bruce H. Harlton, who discovered the holotype.

Horizon and locality: Belle City limestone. N. E. ¼ of sec. 8, T. 4N., R. 6E., Pontotoc County, Oklahoma. Holotype, U. S. Nat. Mus., No. 80524.

[9] Coryell, Journ. Pal., v 2, no. 4, Dec. 1928, p. 378, pl. 51, fig. 1.

HOLLINELLA GRAHAMENSIS (Harlton)
Plate 26, fig. 11

Hollina grahamensis HARLTON, n. sp., Journ. Pal., vol. 1, no. 3, Dec., 1927, p. 203, pl. 32, figs. 2 *a*, *b*.

This species differs from all of the other frilless forms described in its greater height in proportion to the length. Harlton has decided[10] that the "marginal frill" of the original description between the two rows of spines is too slight a ridge to deserve such a designation.

Horizon and locality: Upper Glenn, Love County, about 7 miles south of Ardmore, Oklahoma. Holotype, U. S. Nat Mus., No. 71413.

HOLLINELLA OKLAHOMAENSIS (Harlton)

Jonesina oklahomaensis HARLTON, Journ. Pal., vol. 2, no. 2, June, 1928, p. 133, pl. 21, figs. 3 *a*, *b*.

Differs from the other frilless forms in having coarse granulations which under very high power appear to be almost small spines. The lack of a marginal row of spines is also distinctive. Harlton writes[11] that the "remnants of a marginal frill" described originally "are truly fragments of foreign material and cracks in the shell itself."

Horizon and locality: Belle City limestone, Pontotoc County, Oklahoma. Holotype, U. S. Nat. Mus., No. 72235.

Length	1.11 mm.
Height	.58 mm.
Thickness	.42 mm.

HOLLINELLA MENARDENSIS Harlton
Plate 26, figs. 9 *a*, *b*

H. Menardensis differs from the male of *H. bassleri* (plate 25, figures 5 *a*), *H. shawnensis* (plate 25, figure 4 *a*), and the Oklahoma frilless forms described above, in its elongate rectangular outline in side view. These other forms also lack the pronounced narrow ridge beneath the sulcus. In side view its outline resembles that of the male of *H. emaciata* (plate 25, figure 1 *a*), but the anterior of *H. menardensis* has a much smaller diameter, and the lower part of the sulcus is not so broad as in *H. emaciata*.

Length	1.17 mm.
Height	.68 mm.
Thickness	.51 mm.

[10] Personal communication
[11] Personal communication.

HOLLINELLA cf. MENARDENSIS Harlton
Plate 26, figs. 12 *a*, *b*

The one specimen found has the same rectangular side view, prominent ridge beneath the sulcus and fine closely set spines as *H. menardensis*. The much smaller size could be accounted for if this were a young specimen of *H. menardensis*. But in that case the nodes of the smaller specimen could not be as well developed as in the mature specimen. This is not the case though, for the nodes of the Hollinella in question protrude about twice as much as those on the type of *H. menardensis*. It is found associated with *H. menardensis*.

Length	.91 mm.
Height	.51 mm.
Thickness	.44 mm.

U. S. Nat. Mus., No. 80525.

REGISTER OF KANSAS LOCALITIES

Locality

15. Burlingame limestone, Wabaunsee formation, SE. corner Sec. 3, T.13, R. 15E, about 6 miles south of Topeka, Shawnee County.
18. Ervine Creek limestone, Deer Creek member of the Shawnee foundation, railroad cut by Kansas River just west of Shawnee-Douglas county line crossing Highway 40.
21. Stanton member, Lansing formation, thinly bedded limestone on top of hill, above Kansas River and Union Pacific Railroad track, Highway 32, ¼ mile west of Linwood, Leavenworth County.
22. Stanton, cut on highway 40 just west of Victory Junction, between Lawrence and Kansas City, Kansas.
23. Stanton, U. S. Highway 73 E, 2 miles south of Lansing by Nine Mile School, District No. 17, Leavenworth County.
25. Howard member, Shawnee formation, brick plant cut, north of Gage Park, Topeka.
40. Americas? member, Wabaunsee formation, road cut at foot hill about 1 mile west of Belvue, Wamego County.
42. Neva member, Wabaunsee formation, south of State Agricultural School, Manhattan.
43. Wreford, Chase formation, Permian, on Highway 40 opposite Soldiers Monument, Camp Funston, Geary County.
44. Cottonwood Falls limestone, Council Grove formation, Permian, on Highway 40 at Ogden, Riley County.
45. Fort Riley limestone, Chase formation, Permian, on Highway 40 opposite cemetery, Fort Riley, Geary County.
56. Winfield limestone, Chase formation, Permian, outcrop at juncture on hillside of country road and highway, 8 miles south-east of Lincolnville, Marion County, on route to Elmdale.

58. Cottonwood Falls limestone, Council Grove formation, Permian, Highway 50 S. at west edge of Cottonwood Falls, Chase County.
59. Cottonwood Falls limestone, on Highway 50 S. about ½ mile west of Cottonwood Falls.
60–65. Neva member Wabaunsee formation, going up from 60 to 65, exposure in bluff along Cottonwood Falls River at bridge east of Elmdale, Chase County.
66–67. Cottonwood Falls limestone, near hilltop above 65.
68 *a*. Garrison shale, Permian, just below Wreford limestone, 2½ miles west of Cottonwood Falls, on Highway 50S.
70. Americus member Wabaunsee formation, 1¼ miles straight south of Allen, Lyon County.
71. Burlingame member, Wabaunsee formation, on Highway 50N., 4 miles north of Burlingame, Osage County.

ANNUAL MEETING OF THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

Fort Worth Meeting

The third annual meeting of the Society of Economic Paleontologists and Mineralogists was held at Fort Worth on Friday and Saturday, March 22nd and 23rd, 1929, at the Texas Hotel. Seventeen scientific papers were presented. A list of the titles is appended at the end of this report. A glance at the list shows the unusual scope and variety of the subjects discussed. The excellence both in the manner of presentation and completeness of subject matter of the papers offered by the women is especially noteworthy.

At the business meeting the minutes of the San Francisco meeting were read and approved. Reports were presented by the president, editor, and secretary, and auditors, all of which were unanimously approved. President Moore discussed in detail the relationship of the Society with the parent organization, the American Association. He stated that since the Society was founded by members of the American Association and supported in part by the financial aid of the Association, the future course of the Society naturally linked itself with that of the Association. It seemed desirable for this reason and also for the sake of efficiency, as soon as practicable, to arrange for the business affairs of the Society to be handled through the same office as those of the Association. To bind closer these strings of affiliation that already existed Dr. Moore suggested that the Society consider the advisability of applying to the Executive Committee of the American Association for the privilege of becoming a technical section of the Association. A motion to this effect was made and unanimously adopted.

The question of the name of the Society was briefly discussed. A motion was passed to submit the question of whether the present name should be retained or a new shorter one substituted to the members of the Society and if a change was desired to provide for it by amending the constitution at the next annual meeting.

The Secretary recommended a slight change in the by-laws regarding the membership dues to the effect that dues shall apply as payment to the subscription of the Journal of Paleontology. He pointed out that this change was necessary in order to secure second class postage rates. The old by-laws state that the Journal shall be mailed free to all members. The United States post office will allow second class postal rates only to Journals that have definite stipulated subscription rates to all subscribers. A motion to change the by-laws to conform to postal regulations was unanimously carried. A copy of the new by-laws has been mailed to each member. At the close of the business session the following officers were elected for 1929-30: President, Dr. Marcus A. Hanna; Vice-President, Dr. John B. Reeside, Jr.; Secretary-Treasurer, F. B. Plummer; and Editor, Dr. Joseph A. Cushman, who, with the retiring President, Dr. R. C. Moore, constitute the Society's Council for the year 1929-30.

The retiring president expressed the thanks of the Society to the geologists and paleontologists at Fort Worth who had contributed so largely to the splendid success of the meeting.

The following program was presented:

FRIDAY, MARCH 22ND

Afternoon Session

TERTIARY AND RECENT FAUNAS

1. Claiborne Subsurface Sections of Eastern Texas and Western Louisiana.
   Alva C. Ellisor, Houston, Texas.
2. A Study in Variations in Recent Faunas Along the Gulf Coast of Texas and Louisiana as Found in the Transition from Fresh to Marine Environments.
   Marcus A. Hanna, Houston, Texas.
   W. G. Parker, Houston, Texas.
   Karl E. Young, Houston, Texas.
3. Cretaceous and Lower Tertiary Diatoms From Texas and Louisiana.
   G. Dallas Hanna, San Francisco, Cal.
   Marcus A. Hanna, Houston, Texas.
4. A Section in Peninsular Florida.
   E. R. Applin, Forth Worth, Texas.
   P. L. Applin, Fort Worth, Texas.

5. Notes on the Del Rio and Buda Formations in West Texas.
   Timothy W. Stanton, Washington, D. C.
6. Cretaceous Echinoids of the Genus Macraster.
   W. S. Adkins, Austin, Texas.
7. Upper Cretaceous of Maverick County, Texas.
   Karl E. Young, Houston, Texas.
8. Some Upper Cretaceous Foraminifera From Near Coalinga, California.
   Joseph A. Cushman, Sharon, Mass.
   C. C. Church, San Francisco, Cal.
9. Notes on the Cretaceous of Lower California.
   F. M. Anderson, Berkley, Cal.
   G. Dallas Hanna, San Francisco, Cal.

CARBONIFEROUS FAUNAS

10. Faunal Relations of the Pennsylvanian at McCoy, Colorado.
    I. A. Keyte, Colorado Springs, Colo.
11. Youngest Faunas of the Non-Red Permian of Southern Kansas and Northern Oklahoma.
    Margaret Fuller Boos, Bartlesville, Okla.

SATURDAY, MARCH 23RD

Morning Session

12. Presidential Address: The Environment of Pennsylvanian Life in North America.
    Raymond C. Moore, Lawrence, Kansas.

GENERAL SUBJECTS

13. The Problem of Reworked Foraminifera and Its Bearing on Correlation.
    Joseph A. Cushman, Sharon, Mass.
14. Fish Otoliths, Their Occurrence and Value as Stratigraphic Markers.
    Robert B. Campbell, San Angelo, Texas.
15. The Preparation of Illustrations of Fossils.
    G. Dallas Hanna, San Francisco, Cal.
16. Material on the Use of Slides.
    Helene Jeanne Plummer, Austin, Texas.
17. Galena and Sphalerite in the Fayette at Moore Dome, Fort Bend County, Texas.
    Marcus A. Hanna, Houston, Texas.

REPORT OF THE PRESIDENT

The second year of active existence of this Society has been one of steady growth along practically all lines. Due especially to the enthusiasm and energies of our Secretary-Treasurer, there has been a considerable increase in membership and in the circulation of the Journal; for the success of his labors on behalf of the Society, we owe Mr. Plummer a debt of gratitude. The Editor, likewise, has contributed largely of his time and thought to the all-important task of our publication, and no one more than I appreciates what Dr. Cushman has been called upon to do in bringing the "Journal of Paleontology" to its present creditable place in scientific literature.

Rapid growth is doubtless expectable in a lusty infant, but it appears that in the view of our parent Association we have already passed the nepionic and neanic stages and have achieved ephebic stature. A year ago the Society was recognized by the Association as its legitimate offspring and the relation of affiliation was duly sanctioned; it is now suggested that we join our father as a junior member of the firm and be constituted as a technical section. This is mentioned here as indication of growth, both that which has been made by us as an organization and that of recognition on the part of petroleum geologists generally of the importance of paleontology in their work.

Following precedent of the fall field meeting held in 1927 under auspices of the Fort Worth section of the Society, invitations were issued to the membership early in October, 1928, for an excursion to the many type localities of Pennsylvanian and lower Permian fossiliferous formations in the Kansas and Cottonwood river valleys of eastern Kansas. An itinerary and stratigraphic outline to guide this meeting was prepared and following a route which took the assembled party of 35 to 40 geologists from Kansas City, Missouri, to Florence, Kansas, opportunity was afforded for collection of fossils and samples from almost every stratigraphic unit traversed. Since this section, the standard for the northern part of the Mid-Continent, had not previously been visited by a party, it was felt that the meeting was especially profitable. It is my belief that a short field gathering of paleontologists, preferable sometime each fall, will prove a very worthy objective of our Society, and I recommend to succeeding executive councils that the various local groups within the Society be encouraged and solicited to prepare plans for such meetings as eventually may be arranged in their vicinities. The plan, objective and personnel if these excursions differ from those of the various

field conferences which of late years have been held in the central states. Because of distance, it seems necessary for the Pacific section to make plans separately for any field meetings desired by the far western paleontologists.

In May, 1928, a conference was called at Norman, Oklahoma, partly at my suggestion, to consider plans for more effective co-operation and co-ordination of efforts in stratigraphic and paleontologic investigation of the Pennsylvanian and Permian deposits of the Mid-Continent. Representatives were present from most of the local geological societies and from the state surveys of Iowa, Missouri, Nebraska, Kansas, Oklahoma, Arkansas and Texas. A preliminary organization and plan of work was developed which, with approval of the officers of this Society present, were tentatively designated as activities to be carried on under auspices of the Society of Economic Paleontologists and Mineralogists. The broadening of scope of this research plan and the inclusion in its personnel of non-members of the Society, but especially the feeling on the part of influential members of the American Association of Petroleum Geologists that our program was of special interest and importance to them, has led to the formal sponsoring of the stratigraphic research project by the Association, specific direction of the work to be assigned to interested paleontologists. Your president, who is at present General Chairman of this Carboniferous Research Committee, and secretary-treasurer, Mr. Plummer, who is regional chairman for Texas, have been designated members of the Research Committee of the Association. It is hoped that considerable financial aid for certain needs in stratigraphic and paleontologic research will be forthcoming, and already a few hundred dollars have been allotted to Mr. Plummer's Texas subcommittee for work in progress there. The extent to which plans and accomplishments in this field have been carried has been reported in the February number of the Association *Bulletin.*

The subject of the relation of our Society to the Association of Petroleum Geologists, particularly as regards handling of routine business through the office of the Business Manager, publication and financial assistance from the Association, has received much attention during the present year. After a good deal of correspondence and some personal conferences, a joint meeting of the executive committees of the Association and the Society was held in Tulsa, January 19, 1929. Problems were thoroughly discussed at this time but could not be settled, and a special business meeting of the Society was called at Forth Worth to consider certain changes of status. These

matters are, of course, vitally important to the future of the Society and the *Journal of Paleontology*.

Finally, in connection with scientific contributions offered by our members, I should like to bring to your attention the prevailing lack of any standard or approximately standard practice in the matter of magnifications employed in micro-paleontologic illustrations. There has been improvement in the quality of some of the illustrations submitted for publication, but there is utmost diversity, a meaningless and needless heterogeneity of scale which manifestly serves no purpose and is not helpful in making comparisons. In volumes of the *Journal of Paleontology* so far issued, there are sixty-seven different magnifications used, and as many as twelve different magnifications appear in some cases on a single plate! It is true that size, standing alone, is not ordinarily a specific character, yet it is fairly constant in most species, and it seems desirable to give some attention to it in preparing illustrations. What is the reason or justification of magnifications ×7, ×12, ×23.5, ×47 and ×62, all on a single plate, and showing fossils of the same class and approximate size? Certainly, no good end is served by these odd numbers, and it seems to me desirable not only to recommend some sort of standard set of magnification scales, such as ×5, ×10, ×15, etc., but to indicate preferred scales for certain classes of organisms so that a measure of order might emerge from conditions that are now chaotic. I think that a committee of the Society might well be appointed to investigate this subject and make recommendations that at least should govern illustrations accepted for publication in the *Journal of Paleontology*.

Respectfully submitted,

RAYMOND C. MOORE,
President.

REPORT OF SECRETARY-TREASURER, SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS, MARCH 23, 1929

The membership of the Society of Economic Paleontologists and Mineralogists on March 15, 1928 consisted of 90 charter members and 17 full members elected during 1928. From March 15, 1928 to March 15, 1929 we have elected 92 full members and 13 associate members into the Society, making a total membership of 212. A list of the members is printed in the March issue of the Journal.

The main efforts of the officers of the Society during the past year have been directed to the success of the Journal of Paleontology, which is recognized as the most important service of our organization to paleontology and stratigraphy.

On March 15, 1928, Dr. Marcus Hanna had built up a subscription list, including members of the Society, of 552. Considering that the Journal was then only a year old and that its appeal is to a relatively small specialized group of geologists, this was indeed a splendid achievement. Of this original subscription list 160 failed to renew their subscriptions for Volume 2 of the Journal, and 134 new subscribers were added during 1928 and 1929 making a total mailing list on March 15, 1929 of 526.

Upon the recommendation of Dr. J. A. Cushman, the printing of the Journal was transferred from the University of Chicago Press to the press of Arthur H. Willis of Bridgewater, Massachusetts. This change has made a slight reduction in printing costs and has facilitated greatly the close supervision of the printing and styling of the magazine by our editor.

On account of the large number of plates of fossils, the printing of the Journal, as shown by the financial statement, exceeds the amount received from the subscriptions and membership dues, and publication fund received from the American Association. This deficiency for Volumes 1 and 2 was made up by donations received from individuals and oil companies interested in the success of the Journal. A list of our contributors is published in the March issue of the

Journal. In order to avoid the necessity of soliciting contributions in the future, the Council voted to print a limited amount of selected advertising and to conduct a vigorous campaign to increase the subscription list of the Journal. The Secretary has been successful in selling enough advertising to yield between $400 and $500 of revenue for 1929.

Thanks to the invitation and arrangements of Dr. R. C. Moore, our President, the Society held a very successful fall meeting at Lawrence, Kansas, from October 15-17. About sixty geologists attended and enjoyed an interesting field trip across the Kansas section from Kansas City westward under the guidance of Dr. Moore.

The expenditures and receipts of the Society during the year are shown in the financial statement which follows:

FINANCIAL STATEMENT AS OF MARCH 15, 1929

RECEIPTS

Balance from March 15, 1928	$2,458.51	
Donations toward publication	2,810.00	
Membership dues	733.40	
Subscriptions and sales	3,095.83	
Total receipts		$9,097.74

DISBURSEMENTS

Secretarial and clerical work	$313.58		
Editorial work	245.00		
Postage and express	395.72		
Printed forms, stationery, supplies	319.76		
Insurance	11.77		
		$1,285.83	
Printing of Journal of Paleontology			
Index to Volume 1	32.50		
Volume 2, Number 1	1,013.85		
Volume 2, Number 2	970.50		
Volume 2, Number 3	870.00		
Volume 2, Number 4	1,108.50		
Reprints for authors	326.62		
		4,321.97	
Total disbursements			$5,607.80
Balance on hand as shown by book		$3,489.94	
Balance on hand as bank statement		$3,489.94	
			$3,489.94

(Signed) F. B. PLUMMER,
Secretary.

Audited,
(Signed) MARCUS A. HANNA,
H. V. HOWE.

REPORT OF THE EDITOR

Volume 2 of the *Journal* has been gotten out with a great deal less delay than was experienced with Volume 1. This has been due to several factors. First: there have been plenty of papers ahead for the various issues, and some papers have been withdrawn for publication elsewhere on account of the long waiting list. At the present time, there are about eighteen papers on hand awaiting publication after Number 1 of Volume 3 has been published. The other reason for promptness has been the change in publishers. At present our publisher is only twenty miles away from the Editor so that proof may be gotten and delivered within an hour of the time it is ready. Delay from this source has been cut to a minimum. With the Chicago University Press, several weeks were asked for by the press between each of the proofs and between the final proofs and printing. All this delay has been eliminated, and prompt publication has therefore been possible. Each number has been gotten out either before or early in the month shown on the cover of that number.

Volume 2 contains 390 pages, 51 plates, and numerous maps and text figures. There have been published 28 separate papers by 27 authors. In only one case does the same author appear more than twice in this volume. With the help of the publisher and the officers, it has been possible to use a different paper for Volume 2 which gave better results than were obtained in Volume 1, and for Volume 3, still more satisfactory type of paper has been chosen without added expense.

During the first part of the year, the Editor's office took care of the distribution of all back numbers of the *Journal* as well as the usual editorial duties. This work was later taken over by the Secretary.

Very many favorable comments have been received in regard to the form and appearance of the *Journal*, and it seems to be taking its place with other publications of similar character. The new volume, thanks to the Secretary-Treasurer, will carry several pages of advertising matter which will materially aid in the expense side of the *Journal*. An index has been prepared for both Volumes 1 and 2, giving the authors, titles, and some of the more important groups.

JOSEPH A. CUSHMAN, *Editor,*
Journal of Paleontology.

RESEARCHES IN PALEONTOLOGY

Professor G. D. Harris, assisted by Dr. Katherine Van Winkle Palmer and other members of his department, has just completed the final number to Volume I of the Paleontographica Americana describing east American Veneridae. The monograph contains 522 pages and 76 plates. Professor Harris and Dr. Palmer are also working on Volume 7 of the Bulletin of American Paleontology, which will contain papers on upper Eocene Mollusca.

Professor F. L. Whitney, professor of paleontology at the University of Texas, is completing a monograph on the fauna of the Glen Rose of the Lower Cretaceous of Texas.

Dr. R. C. Moore is working on fossil collections from Kansas, Oklahoma, and Texas with special reference to the problem of the correlation of strata of the three states.

Nelson Sayre of the Geological Department of the University of Pennsylvania has completed an extensive paper on the fauna of the Drum limestone in Kansas, a division of the Kansas City formation of Pennsylvanian age. A number of new species, chiefly gastropods and cephalopods, are described. Preliminary work on this research was done at the University of Kansas and continued under the direction of the late Dr. Stuart Weller of the University of Chicago.

J. Harlan Johnson of the Colorado School of Mines is carrying on studies in the stratigraphy and paleontology of the Benton Cretaceous formation. During the past year Mr. Johnson has been working on a paper entitled "Paleontology and Faunal Distribution of the Lower Sangre de Cristo (Pennsylvanian) Formation of South-Central Colorado."

Kenneth Caster in the Department of Geology at Cornell University is preparing a monograph for publication on the Devonian and Carboniferous faunas of northwestern Pennsylvania.

John Wells, instructor in geology at the University of Texas, in

connection with his graduate studies at Cornell University is preparing a monograph on the Devonian coral reefs of central New York.

Dr. A. A. Olsson of the Geological Department of the International Petroleum Company at Negritos, Peru, has completed a paper on the upper Eocene Mollusca of Peru which will be published in the Bulletin of American Paleontology at Cornell.

J. Mark Jewell, working under the direction of Dr. R. C. Moore at the University of Kansas, is making a special study of the Iola limestone in eastern Kansas and adjacent portions of western Missouri. Special attention is being given to paleontology.

Miss Helen Tucker has presented for publication in the Bulletin of American Paleontology a paper describing new American East Coast Pectens. Miss Tucker has been collecting fossils and material in Cuba, which she expects to study at Cornell next year.

Professor John L. Tilton of the Geology Department of the University of West Virginia is engaged in a systematic investigation of the Permian deposits of West Virginia.

Norman Newell, graduate student at the University of Kansas, is studying the fossils of the Plattsburg limestone of the Lansing (Pennsylvanian) formation.

Professor Bradford Willard reports that the following researches pertaining to paleontology and stratigraphy are under way in the Geological Department of Brown University:

1. Carboniferous amphibian foot prints in Rhode Island and Massachusetts.
2. Evolutionary stages of *Platystrophia.*
3. Cambrian and Carboniferous red beds in Rhode Island and Massachusetts.

Dana Wells, graduate student at the University of Kansas, is studying the fossils of the Garrison shale of the lower Permian of Kansas.

W. Storrs Cole of the Geological Department of Cornell University has recently published a paper on some small Claiborne fossils, (Bull. Pal. Soc., No. 1928).

Robert Roth, geologist for the Indian Territory Illuminating Oil Company, has published recently in the publications of the Wagner Free Institute of Science, Philadelphia, a paper on a revision of the ostracod genus *Kirkbya* and subgenus *Amphissites.*

Dr. Clinton R. Stauffer, Professor of Paleontology at the University of Minnesota, is preparing for publication a paper on Decorah shade conodonts, an Ordovician micro-fauna. Fragmentary conodonts have been found in the Decorah shale from time to time, but in an excavation in the Mississippi River bluffs in Minneapolis last year these forms were encountered in great numbers and in an excellent state of preservation. These are being studied and will be described for publication within the next few months.

J. B. Christner, graduate student in geology at the University of Texas, is working on the fauna of the Comanche Peak of central Texas.

Miss Alva C. Ellisor, paleontologist of the Humble Oil Company, is preparing a paper on the stratigraphy of the Claiborne formations of east Texas. A summary of her studies was presented at the Fort Worth meeting of the Society of Economic Paleontologists.

Earl E. Marshall at the University of Kansas is studying the fauna and stratigraphic variations of the Chanute shale, which lies between the Drum and the Iola members of the Kansas City formation, a Pennsylvanian formation in the Kansas section.

Mrs. E. R. Applin and Paul L. Applin are writing a paper on the geologic section in the peninsula of Florida as revealed by a study of well samples.

I. A. Keyte of Colorado Springs, Colorado, is studying the fauna of the Pennsylvanian at McCoy, Colorado. From this interesting locality Mr. Keyte has collected a large fauna including sixty beautifully preserved crinoids.

Miss Beatrice Bolton of the Geological Department of Cornell University is preparing a report on the Paleontology of upper Eocene formations of America. She is spending the spring months at Barton Cliff, England, and Isle of Wight collecting material for comparison with American fossils with special reference to those that occur in the transition beds between Eocene and Oligocene formations.

Dr. Marcus A. Hanna and W. G. Parker of the Gulf Production Company, Karl E. Young of the Rycade Oil Corporation, and M. M. Kornfeld of the Shell Petroleum Corporation are engaged in a study of Recent faunas along the Gulf Coast of Texas and Louisiana as found in the transition from fresh water to marine environments. A summary of the preliminary results of these studies was presented by

Dr. Hanna at the Fort Worth meeting of the Society of Economic Paleontologists.

Bruce Harlton, paleontologist for the Amerada Petroleum Corporation, has written a paper on Pennsylvanian ostracods of Menard County, Texas. This will be published soon by the Bureau of Economic Geology, University of Texas.

Robert Campbell of San Angelo, Texas, is engaged in a study of fish otoliths. He has translated and abstracted the German literature on this subject, collected extensively from the Tertiary and Cretaceous formations of Texas, and prepared a paper that was presented at the Fort Worth meeting of the Society of Economic Paleontologists entitled "Fish Otoliths, Their Occurrence and Value as Stratigraphic Markers."

M. M. Kornfeld of the Shell Petroleum Corporation, Gulf Coast Division at Houston, Texas, on April 12 completed a Recent foraminiferal sample-collecting survey of the Louisiana coastline through the co-operation of the Louisiana Department of Conservation; this work will be incorporated in a masters thesis at Stanford University in 1929-1930 on the taxonomy of Recent Foraminifera of Texas and Louisiana and will supplement the ecologic studies of Hanna, Parker, and Young.

ACTIVITIES OF THE LOCAL PALEONTOLOGICAL SOCIETIES

Tulsa Micropaleontological Society

The paleontologists at Tulsa, Oklahoma, have organized a local society known as the Tulsa Micropaleontological Society. The aim of the Society is to assemble data on, and aid for a consistent classification of stratigraphy and paleontology as related to the Mid-continent field. The officers are: Ira Cram, paleontologist for the Pure Oil Company, President; Dan Neufer of the Carter Oil Company, Vice-President; George Buchanan, Treasurer; and F. A. Bush of the Sinclair Oil Company, Secretary.

Meetings are held bi-monthly in the Tulsa Building. The programs consist of reports by members. The reports are arranged as follows: A paleontologic project or stratigraphic problem is assigned by the President to each member in advance to work up and to present to the Society. On the date at which a report is made, a resumé of the data pertaining to the problem is copied and distributed to each member of the Society. In this way the programs have proved to be not only original and interesting, but they also furnish new, helpful contributions to the knowledge of Mid-Continent stratigraphy. The projects covered during 1929 are as follows:

"Ostracods of Menard County, Texas," by Bruce H. Harlton. "Fossil Marine Indicators of Climatic Conditions," a review by Frank Greene. "Notes and Observations on Living Ostracoda found in the vicinity of Tulsa," by Messrs. Harlton and Bush. "Symposium on the Lower Paleozoic Section of the Arbuckle Mountains," by several members of the Society. "Recent Deposits of the Mississipian Delta," by Robert Dott. "The Micro-Paleontology and Lithology of the Springer Formation," by Dan Neufer.

Fort Worth Paleontological Society

At the winter meeting of the Fort Worth Paleontological Society held at Texas Christian University February 14, Dr. Frank Carney read a paper on vertebrate paleontology as applied to prehistoric man, and Jerome Smiser gave a review of his studies on determination of echinoid fragments in the Cretaceous.

At the spring meeting held April 11 Professor W. M. Winton gave an interesting talk on recent advances in paleontology.